

Injection mold

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
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Abstract of EP1072379

An injection mold for an injection molding machine includes a first mold half having one of at least one mold cavity and at least one mold core. The first mold half is mounted on a rotatable turret block rotatable on an axis perpendicular to the central axis of the first mold half for rotating the at least first mold halves thereof into alignment with the second mold half. The first mold half is moved towards and away from the second mold half via means for moving, wherein the second mold half is stationary and supported by a frame. The rotatable turret block is further for clamping the first mold halves and the second mold half together.

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(54) **Injection mold**

(57) An injection mold for an injection molding machine includes a first mold half having one of at least one mold cavity and at least one mold core. The first mold half is mounted on a rotatable turret block rotatable on an axis perpendicular to the central axis of the first mold half for rotating the at least first mold halves thereof into alignment with the second mold half. The

first mold half is moved towards and away from the second mold half via means for moving, wherein the second mold half is stationary and supported by a frame. The rotatable turret block is further for clamping the first mold halves and the second mold half together.

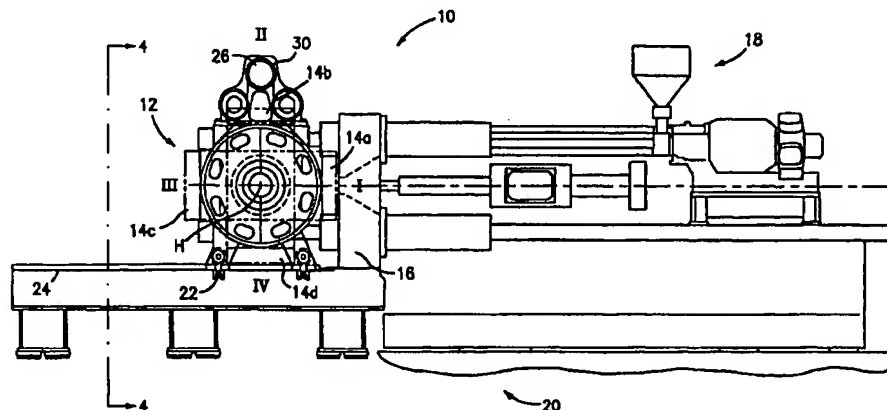


FIG. 1

Description

BACKGROUND OF THE INVENTION

[0001] This invention is directed to an injection mold of a turret style injection molding machine, and more particularly, to an injection mold having a rotating and longitudinally movable turret block with a plurality of mold halves rotatable and movable into engagement with a non-rotatable mold half, which machine also includes at least one station for providing additional molding related operations.

[0002] Injection molding machines having turret configurations for moving mold halves into and out of alignment with other mold halves are well known in the prior art. A turret type configuration for injection molding is beneficial since it lends itself to high volume production of molded parts. This is true since different molding related operations can be performed using the turret configuration, simultaneous to the actual molding of the part. That is, while one part is being molded on the turret block, another part having already been molded or to be molded can be subjected to a plurality of post molding or pre-molding operations. These operations include, for example, injecting, holding, cooling and ejecting, each of which can be performed at a different angular position relative the turret block.

[0003] The following patents disclose turret style injection molding machines wherein the turret has a vertical axis of rotation.

[0004] U.S. Patent 4,734,023 to Nesch et al. discloses an injection molding machine which uses a four to eight sided turret block that rotates about a vertical axis and which is mounted between the stationary and moving platens of the machine. The turret is also slidable on lower tie bars between the platens.

[0005] U.S. Patent 4,427,359 to Fukuoka discloses an injection stretch blow molding machine. The machine incorporates a four sided turret block positioned on a vertical axis wherein preforms are injection molded in a first position of the four sided turret block. Preforms are temperature conditioned inside a second conditioning mold at a second position of the block. The preforms are blow molded at a third position and ejected at a fourth.

[0006] U.S. Patent 4,449,913 to Krishnakumar discloses a rotary injection turret for use in making preforms. The patent teaches a turret block rotatable on a vertical axis, which block uses two of the turret block positions for post mold treatment of preforms while the preforms are still on mold cores. Accordingly, after injection, hold and some cooling at a first station, the turret block rotates to a second position where cooling fluid is blown onto the exterior surface of the preforms in order to cool the preforms. At a third position, the preforms are inserted into a conditioning mold from the turret block where the gate vestige is trimmed and further temperature conditioning is performed.

[0007] Additional patents which disclose vertical

axis turrets are U.S. Patents 4,444,711 to Rees; U.S. Patent 4,330,257 to Rees; U.S. Patent 4,363,619 to Farrell; U.S. Patent 3,833,329 to Ulmachneider; and U.S. Patent 2,333,056 to Thoreson.

[0008] The following patents disclose injection molding machines using rotary turret block each of which have a horizontal axis of rotation.

[0009] U.S. Patent 4,836,767 to Schadt et al. discloses a swing plate molding machine. The swing plate molding machine includes two core mold halves and one single cavity mold half. During molding, parts are caused to remain on the cores of the mold halves and are swung to an outboard position where the parts are transferred into a four sided turret block arrangement for continued cooling. The turret rotates on a horizontal axis and may contain a mechanism for temperature conditioning at one of its stations.

[0010] U.S. Patent 4,370,124 to Buja discloses a modular rotary molding machine. The rotary style machine disclosed has a wheel which rotates about a horizontal axis. The entire wheel and additional assembly is mounted on a movable carriage with respect to a fixed injection unit. The diameter of the wheel is adjustable to vary the number of molds processed. Each mold thereon is filled individually and then clamped and packed by units positioned on board the wheel.

[0011] U.S. Patent 4,243,362 to Rees discloses a composite molding apparatus for molding articles from two materials. The apparatus includes a four sided turret block rotatable between two opposed faces about a horizontal axis. The block is mounted slidably between a fixed and a moving platen of a horizontal injection molding machine. Two material molding is achieved by injecting different materials from separate injectors when the block is in each of two positions.

[0012] Additional turret style injection molding machines having a horizontal axis of rotation include U.S. Patent 3,988,100 to Julien; U.S. Patent 3,881,855 to Farkas; and U.S. Patent 3,730,665 to Fortin.

[0013] The prior art also includes a plurality of two platen injection molding machines, some of which are discussed as follows.

[0014] U.S. Patent 5,338,171 to Hayakawa discloses a die clamping apparatus with an aligning device. The apparatus includes a two platen clamp with alignment means provided by vertically adjustable trunnions under the movable platen. The trunnions are moved by cylinders which respond to deflection signals sensed at the ends of outriggers mounted to the moving platen.

[0015] U.S. Patent 5,336,462 to Wohlrab discloses a mold closing apparatus for an injection molding machine. The machine includes a two platen clamp in which stroke cylinders are positioned inside tie bars, the ends of which also act as clamp pistons.

[0016] U.S. Patent 5,314,327 to Stein discloses a mold clamp for an injection molding machine. The machine includes a two platen clamp with means to help align the mold halves. Adjustable rollers are used

on a moving platen carriage and adjusting means are built into the carriage/moving platen assembly for improving alignment.

[0017] US-A-3838961 discloses an injection-blow molding apparatus comprising a rotatable turret means being rotatable on a vertical axis. The apparatus comprises a stationary die plate, movable die plate an injection molding female mold secured to the stationary die plate, a blow molding female mold secured to the movable die plate, and a male mold disposed between the injection molding female mold and the blow molding female mold and wherein a parison is injection molded about the male mold by the cooperation thereof with the injection molding female mold and then the male mold carrying the parison is combined with the blow molding female mold to blow mold the parison, there are provided a horizontal beam extending above the stationary and movable die plates, a male mold supporting member having male molds on its opposite sides and a vertical shaft, a carriage rotatably supporting the vertical shaft and slidably mounted on the beam.

[0018] BE-A 873200 discloses a process for injection molding as well as an apparatus for realisation of the process according to the first part of claim 1. No details about how the turret is mounted or translated are disclosed. Further, this document gives no teaching about how a clamp force or mold break force is provided with respect to the molding operation. No stationary platen is shown or discussed.

[0019] With respect to the prior art discussed above, no injection molding machines are disclosed having the objects and advantages discussed below and derived from the device disclosed herein. That is, each of the prior art devices discussed above has a relatively complex construction, requiring multiple mold platens and a greater number of moving parts. Accordingly, these devices inefficiently use excess floor space, exhibit greater energy consumption, and have relatively long cycle times.

[0020] There exists a need, therefore, for an injection mold to be used in a two platen injection molding machine having a turret clamp with a plurality of movable platens, wherein the turret clamp is rotatable on a horizontal axis and longitudinally movable for placement into and out of engagement with another platen, thereby reducing floor space usage and energy consumption and increasing efficiency.

SUMMARY OF THE INVENTION

[0021] The primary object of this invention is to provide an injection mold which is carried by a longitudinally movable and rotatable turret block for an energy and space efficient injection molding machine having a reduced cycle time.

[0022] Another object of this invention is to provide an injection mold carried by a longitudinally movable and rotatable turret block, wherein combinations of pre-

mold and post mold operations may be efficiently achieved on one machine using different stations of the turret block, thereby reducing cycle time.

[0023] Still another object of this invention is to provide an injection mold carried by a longitudinally movable and rotatable turret block, wherein operations such as loading, injection, label loading, temperature conditioning, and direct unloading of molded parts can be achieved at different angular positions in a continuous and efficient manner using one machine having a plurality of stations, thereby reducing cycle time, floor space consumption, and energy consumption.

[0024] And yet another object of this invention is to provide an injection mold carried by a movable and rotatable turret block which includes a plurality of mold halves movable toward and away from a mating stationary mold half for forming molds for injection molding a variety of parts in an energy and cycle time efficient manner.

[0025] The disclosed objects and advantages are achieved by the injection mold as claimed of the present invention. The injection mold comprises at least one first mold half having one of at least one mold cavity and at least one mold core. The first mold half is carried by a rotatable turret block rotatable on a horizontal axis perpendicular to the central axis of the first mold half for rotating said first mold half into alignment with a second mold half for forming a mold for molding a molded article. The first mold half is mounted on the rotatable turret means and is rotated relative to the second mold half by said rotatable turret means. The first mold half is at least one of horizontally and vertically movable toward and away from the second mold half via means for moving, wherein the first mold half is stationary and supported by a frame.

[0026] The details of the present invention are set out in the following description and drawings in connection with preferred embodiments wherein like reference characters depict like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a side elevational schematic view of an injection molding machine in a closed position;
FIG. 2 is a partial elevational side view of an injection molding machine in an open position;
FIG. 3 is an end partially cross-sectional view taken along line 3-3 of FIG. 2;
FIG. 4 is an end view taken along line 4-4 of FIG. 1;
FIG. 5 is a side elevational and partially cross-sectional view from the side opposite of that shown in FIG. 2 with the injection molding machine in the partially open position;
FIG. 6 is an end elevational and detailed view taken along line 6-6 of FIG. 5;
FIG. 7 is an overhead schematic view of the injec-

tion molding machine of the present invention similar to that shown in FIG. 1 showing an embodiment including a pair of injecting mechanisms;

FIG. 8 is a side elevational schematic view of an injection molding machine of the present invention similar to that shown in FIG. 1, showing an embodiment thereof including a cooling station;

FIG. 9 is a side elevational and schematic view of an injection molding machine of the present invention similar to that shown in FIG. 1, showing an embodiment thereof including a label loading station;

FIG. 10 is a side elevational and schematic view of an injection molding machine of the present invention similar to that shown in FIG. 1, showing an embodiment having an insert loading station and an article removal station;

FIG. 10A shows a more detailed embodiment of a schematically shown molded article removal station of FIG. 10;

FIG. 11 is a side elevational and partially schematic view of another embodiment of an injection molding machine;

FIG. 11A is an end view of the injection molding machine of FIG. 11 taken from line 11a-11a;

FIG. 12 is a side elevational and partially schematic view of another embodiment of an injection molding machine, similar to that shown in FIG. 11;

FIG. 13 is a side elevational and partly schematic view of an embodiment of the present invention including a blow molding station;

FIG. 14 is a detailed side view of the blow molding station of FIG. 13 in the open position;

FIG. 15 is a side elevational view similar to FIG. 13 showing an alternate embodiment;

FIG. 16 is a schematic view of a preform mold core layout suitable for use in the present invention;

FIG. 17 is a side elevational and partially schematic view showing another embodiment similar to FIG. 1;

FIG. 18 is a partial elevational side view of the clamp portion of the machine of FIG. 11 in an open position;

FIGS. 19-20 are side elevational and partially schematic views of other embodiments of an injection molding machine, similar to that shown in FIG. 1;

FIG. 21 is a side elevational and partly schematic view of the machine of FIG. 14 in the open position;

FIG. 22 is a chart that summarizes some of the operations that can be performed at various mold stations;

FIG. 23 is a side elevational and partly schematic view of another embodiment similar to FIG. 13 with a second clamp and injection unit mounted on the turret;

FIG. 24 is a side elevational view similar to FIG. 14 showing an alternate embodiment;

FIG. 25 is a chart that summarizes some of the

operations that can be performed at various mold stations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0028] Referring now to the drawings in detail there is shown in FIG. 1 an elevational and schematic side view of the injection molding machine, which is designated generally as 10. Injection molding machine 10 generally includes a rotatable turret block 12 with a plurality of movable mold halves 14a-14d, a stationary mold half and platen 16 and injection unit 18, all positioned on base 20.

[0029] Injection molding machine 10 may be used for molding a variety of different types of articles and accordingly, is not limited for use with any particular type of article. Preforms are referred to throughout this description by way of example only.

[0030] While the block is shown throughout this description as rotatable on a horizontal axis, and this is the preferred embodiment, it is feasible that a similar design of a movable turret block providing the damping action may be provided which is rotatable on a vertical axis.

[0031] As shown in FIGS. 1-5, turret block 12 is preferably longitudinally movable on base 20 via a set of rollers 22 attached to the bottom of the turret block and thereby provides a mold clamp force. Base 20 includes hardened ways 24 which engage rollers 22, wherein rollers 22 engage the underside of ways 24 so as to counteract upward forces and tipping forces that may act on the turret block assembly. Turret block 12 is rotatable preferably by a motor, preferably an electric servo drive motor 26 and preferably on a horizontal axis H through arcuate sectors preferably of substantially 90°. Preferably, the electric servo drive motor is connected via a belt drive 30 to axis H for rotating turret block 12, as shown in FIG. 4, while the electric servo drive motor is preferably mounted on one of turret block carriages 32a and 32b extending from base 20.

[0032] As shown in FIG. 5, turret block 12 includes a plurality of movable mold halves, i.e. movable mold halves 14a-14d each of which includes a set of mold cores 34a-34d, respectively, each set having at least one mold core, adapted for engagement with a set of mold cavities 36, each set including at least one mold cavity and located in stationary mold half and platen 16. Preferably, four movable mold halves or faces 14a-14d are provided on turret block 12, although any number supportable by the size of the turret block 12 can be used. Sets of mold cores 34a-34d are adapted to be rotated into horizontal and vertical alignment with sets of mold cavities 36.

[0033] Referring still to FIG. 5, turret block 12 includes sets of ejector pistons or stripper rings 38a-38d, and a system for the operation thereof, which operate on sets of mold cores 34a-34d and strippers posi-

tioned on movable mold halves 14a-14d, respectively. Accordingly, sets of ejector pistons or stripper rings 38a-38d are positioned within turret block 12 and parallel to sets of mold cores 34a-34d and perform the function of stripping the mold cores of finished molded articles, for example, preforms, such as those shown in FIGS. 8-10. Each movable mold half and platen 14 includes at least one ejector piston in each set 38a-38d for stripping finished articles from sets of mold cores 34a-34d. For the detailed design of the ejector piston or stripper ring system for use with sets 38, reference is made to U.S. Patent No. 5,383,780, issued June 24, 1995, to the assignee of the present invention, for incorporation by reference of a design of the ejector piston or stripper ring system, particularly column 4, line 29, to column 7, line 6, and FIGS. 1-8. Preferably, the ejector piston or stripper ring system is actuated via the hydraulic services supplied to the turret block, as discussed below. The hydraulically actuated ejector piston or stripper ring system actuated by on board hydraulic services is the preferred design, however, other designs may be used.

[0034] Turret block 12 is movable backward and forward along hardened ways 24 on base 20 via piston/cylinder assemblies 40a-40d positioned in stationary mold half and platen 16, as shown in FIG. 5. Preferably four piston/cylinder assemblies 40a-40d, as shown in FIGS. 2, 3 and 5, are used which are positioned in the corners of stationary mold half or platen 16. Each piston/cylinder assembly 40a-40d includes a piston 42a-42d (42a, 42c and 42d not shown), which pistons 42a-42d are attached to tie bars 44a-44d, respectively, which tie bar acts as the piston shaft. Accordingly, tie bars 44a-44d extend from the piston/cylinder assemblies 40a-40d and are connected at an opposite end to turret block 12. In order to move turret block 12 backward and forward relative stationary mold half and platen 16, pressurized fluid is forced into cylinders 46a-46d against pistons 42a-42d, respectively. The side of pistons 42a-42d in which pressurized fluid is forced against, determines the direction in which turret block 12 moves relative stationary mold half and platen 16, that is, either into an open or closed position, shown in FIGS. 2 and 5, respectively. Tie bars 44a-44d pass through the turret block carriages 32a and 32b and are attached thereto via retaining nuts 48a-48d, as shown in FIG. 6, respectively.

[0035] Services S, shown schematically in FIG. 3 and 4, are provided to turret block 12 via a rotary union 50, also shown schematically. Accordingly, as turret block 12 rotates, services S are continuously supplied to the movable mold halves 14a-14d. Such services S include the supply of electricity, pressurized fluid, cooling fluids, and hydraulic fluids, etc.. For using these services, turret block 12 also includes the required circuitry and control valves 51 (shown schematically) on board and movable and rotatable with the turret block.

[0036] Injection unit 18, preferably in the form of a reciprocating screw injection unit, is connected with sta-

tionary mold half and platen 16 positioned on base 20 for providing melt to the mold cores for molding. Injection unit 18 is preferably movable into and out of engagement with stationary mold half and platen 16 by means of carriage cylinders (not shown) on rollers and hardened ways, similar to as described above for use with turret block 12. In one embodiment, as shown in FIGS. 7, injection molding machine 10 can provide co-injection of articles, for example, preforms. For this arrangement, two conventional reciprocating screw injection units 18a and 18b are used to feed two different kinds of resins into conventional mold cavities, such as those shown in stationary mold half and platen 16, which mold half and platen 16 includes a two material hot runner system 52 which delivers both resins into each mold cavity within stationary mold half and platen 16 for molding multi-layered articles, for example, preforms.

[0037] As discussed briefly above, injection molding machine 10 may include a plurality of stations, preferably stations I-IV, although more or less stations may be used, positioned adjacent the periphery of turret block 12, which stations I-IV are used for the performance of pre-molding or post-molding operations.

[0038] For example, and as shown in FIG. 8, an embodiment of injection molding machine 10 may include a temperature conditioning station 54, the design of which is not critical, preferably at station II, where temperature controlled air or other coolant is preferably directed onto newly molded articles to increase the rate of cooling thereof. If used with the co-injection case discussed above, the temperature conditioning station also enhances bond strength between the layers of the different resins used during co-injection. Based on the location of other stations, as discussed below, temperature conditioning station 54 may be located at one of the other stations, for example stations III and IV.

[0039] In FIG. 9, another embodiment of injection molding machine 10 is shown wherein a label loading robot 56 is used to attach labels to the outside of molded articles after they have been rotated away from the molding station through an arcuate sector of 90° to a second station II. In label loading robot 56, labels are preferably conveyed inside a tube 60 to positioning areas 62 and retained at positioning areas 62 via the application of vacuum. Positioning areas 62 are positioned over at least one finished molded article while the molded article are positioned at the second station II. For applying the labels, the vacuum is preferably reversed to positive pressure and the labels are blown from positioning areas 62 into contact with preferably still hot but finished molded articles 39 for adhering the labels to the articles.

[0040] In FIG. 10, still another embodiment of injection molding machine 10 is shown where a robotic article liner loader 64, for example, a preform liner loader, is preferably positioned in at least one of stations I-IV, and

preferably at station II, wherein liners 66 are loaded onto the mold cores of sets 34a-34d of each of movable mold halves 14a-14d, respectively, of turret block 12 and block 12 is preferably rotated clockwise. Accordingly, prior to being rotated into alignment, both vertically and horizontally, and longitudinally moved into engagement with stationary mold half and platen 16, one of sets of mold cores 34a-34d are loaded with the liners 66. Preferably, liners 66 are held on the mold cores of sets 34a-34d of movable mold halves 14a-14d, respectively, by vacuum source 65 (shown schematically) applied through the mold cores. Subsequently, turret block 12 is rotated so that mold cores of sets 34a-34d with liners 66 thereon are in alignment with set of mold cavities 36. Turret block 12 is then preferably moved to the closed position such that one of movable mold halves 14a-14d and stationary mold half and platen 16 are engaged. In this manner, resin may be injected by injection unit 18 over liners 66 for producing a two-layered molded article, for example, a two-layered preform.

[0041] In another embodiment, and also shown in FIG. 10, one of stations I-IV, preferably station III, may include a finished article removal mechanism 67 (shown schematically), which functions to remove finished molded articles 39 from the mold cores of sets 34a-34d of movable mold halves 14a-14d, respectively. As shown in FIG. 10, removal mechanism 67 is positioned at an article removal area 74 which is substantially unobstructed by molding area 76, defined between the movable mold halves of turret block 12 and mold half 16, unlike machines using turret blocks which are positioned between two mold halves. Accordingly, article removal area 74 is located outside of the article molding area 76 and the other stations, allowing for clear unobstructed access to finished molded articles for removal. This feature is particularly applicable to the removal of large molded articles or hard to handle molded articles, such as furniture and complex automotive parts. As a result, substantial space saving is achieved, wherein extra space does not have to be provided upon separation of the mold halves to accommodate the removal device. Similar to removal system 67, another advantage is that unobstructed access to finished molded parts is also provided for manual part removal.

[0042] In a preferred embodiment, article removal mechanism 67 is in the form of a robotic device (shown schematically as 67) automatically movable into and out of engagement with finished molded articles in area 74.

[0043] In another preferred embodiment, and which is applicable to the removal of molded closures from movable mold halves 14a-14d, an external unscrewing head (shown schematically as 67) may be used. The unscrewing head is preferably mounted on base 20 at station III in area 74 in which multiple chucks, preferably one per cavity, are used to unscrew molded closures from the mold cores of sets of mold cores 34a-34d. An unscrewing head for use herein is shown in U.S. Patent 3,328,844, issued July 4, 1967, to the assignee of the

present invention which is hereby incorporated by reference with particular attention to FIGS. 1-8, and column 3, line 25 to column 8, line 56.

[0044] And another preferred embodiment of the removal mechanism is shown in FIG. 10A, which depicts an enlarged detailed version of schematic removal mechanism shown in FIG. 10. This removal mechanism is preferably in the form of airveyors 69 positioned for alignment with mold cores, at station III. The airveyors include tubes 68 for applying vacuum to the finished molded articles 39. Airveyors 69 may be moved toward and away from turret block 12 via a movable platform 70 movable via a piston/cylinder assembly 72, which is preferably connected with platform 70. Accordingly, as the articles are continually cooled during rotation from station to station, finished articles are then removed via molded article removal mechanism 67.

[0045] Alternative embodiments 110 of the turret article molding machine are shown in FIGS. 11, 11A and 12, wherein addition space savings are acquired by arranging turret blocks 112a and 112b, of FIGS. 11, 11A and 12, respectively, and movable mold halves 114a-114d thereof, to be movable in a vertical plane relative stationary mold half 116. In FIGS. 11 and 11A, turret block 112a is rotatable on horizontal axis H_1 while in FIG. 12, turret block 112b is rotatable on horizontal axis H_2 , wherein H_1 extends perpendicular to and H_2 extends parallel to the horizontal longitudinal axis HL of base 120. Blocks 112a and 112b are preferably rotatable after moving a complete stroke upward from base 120 and stationary mold half and platen 116.

[0046] In these embodiments, stationary mold half and platen 116 is supported on base 120 such that the face thereof lies in a horizontal plane parallel to axis HL. Injection unit 118 is arranged similar to unit 18 of FIG. 1, as shown, and is vertically positioned as required to inject melt into the mold cavities of set 136 of mold half and platen 116. For the embodiment shown in FIG. 12, the injection unit, instead of extending into the stationary mold as shown in FIG. 11 and 11A, extends into the bottom platen 178. Accordingly, additional space is provided for additional injection units for injecting multiple materials. The roller and track mechanism of block 12 is preferably eliminated in this embodiment and turret blocks 112a and 112b are vertically movable on vertically extending tie bars 144a-144d (144c and 144d not shown) relative stationary mold half and platen 116. The tie bars may include clamping mechanisms such as pistons and a mechanism is provided for moving blocks 112a and 112b under control to and from base 120. Stations I, II, III, and IV may include any of the mechanisms discussed above for turret block 12 for performing the operations discussed above.

[0047] In these embodiments, the operation performing mechanisms at the stations are supported at a higher vertical orientation and preferably receive this support off of base 120, although other separate sup-

port means may be used. The mechanisms located at stations I-IV may also be simultaneously vertically movable by known means to accommodate the vertical movement of blocks 112a and 112b, to maintain continuous performance of operations at the changing vertical positioning of blocks 112a and 112b.

[0048] The remaining features and alternative embodiments of machine 110 are essentially the same as discussed above for machine 10 and accordingly the above descriptions of these features apply equally to these embodiments. Any modifications which may apply for using these features with these embodiments are well within the skills of those in this art and accordingly are not described herein in detail.

[0049] However, for the embodiments of FIGS. 11, 11A and 12, finished molded articles may be directly unloaded onto elevated conveyors or other downstream equipment (not shown) with raised infeeds, if desired, thereby eliminating the need for additional article removal equipment.

[0050] In operation, one of mold halves 14a-14d and mold half and platen 16 are closed as shown in FIG. 1, aligning one set of mold cores 34a-34d, for example mold half and platen 14a with set 34a, with set of mold cavities 36. Resin is preferably injected through injection unit 18, or if two units are used for co-injection, units 18a and 18b, thereby filling the mold. The finished molded articles 39 are allowed to cool at least to the point where opening the mold will not deform the molded articles. Movable mold half and platen 14a, for example, and stationary mold half and platen 16 are then opened, as shown in FIGS. 2 and 5, whereby turret block 12 is preferably moved on rollers 22 over hardened ways 24 by piston/cylinder assemblies 40a-40d moving tie bars 44a-44d away from stationary mold half and platen 16.

[0051] Turret block 12 is then rotated 90° to present a fresh set of mold cores, for example set 34b of mold half and platen 14b into alignment and engagement with set of mold cavities 36. Since the molded articles shrink onto the cores they will continue cooling as turret block 12 rotates so that the mold can be open much sooner than with any conventional molding cycles. For example, while molded articles positioned on the set of mold cores 34a on movable mold half and platen 14a are moved from station I to each of stations II, III and IV, sets of mold cores 34b-34d of mold halves 14b - 14d, are presented for engagement with the set of cavities 36 of stationary mold half and platen 16, and molded articles on movable mold half and platen 14a are subject to at least one post molding operation and in many times a plurality of post molding operations including cooling.

[0052] In addition, pre-molding operations, such as liner insertion, for performing multi-layered articles such as preforms, can be accomplished prior to rotation of movable mold half and platen 14a, or any other mold half, back into alignment and engagement with stationary mold half and platen 16. Accordingly, at each of sta-

tions II, III and IV, post molding or pre-molding operations such as cooling and labeling and finished molded article removal, as shown in FIGS. 7, 9 and 10, respectively, and liner or insert loading as shown in FIG. 10, and discussed above, can be carried out.

[0053] For example, and more specifically, as a movable mold half moves to station II, temperature conditioning system 54 may be used to hasten cooling of molded articles, for example, preforms. Alternatively, at station II, as shown in FIG. 9, labels via label loading robot 56 may be applied to the finished molded articles, for example, preforms, in the manner discussed above. As shown in FIG. 10, finished preforms may be removed at station III from, for example, set of mold cores 34a of movable mold half and platen 14a via ejector pistons in set 38a, driven by the supplied hydraulic services, and article removal device 67, as discussed in detail above. Due to the unobstructed location of removal area 74 with respect to molding area 76, the article removal device, preferably a robot shown schematically as 67, is easily moved into position for removal. If closures or the like with inner threads or the like are being molded, an external unscrewing head may be positioned in removal area 74 for facilitating removal of the closures, as discussed in the incorporated reference.

[0054] FIG. 10 also shows an opposite direction of rotation of turret block 12. In this embodiment, and maintaining the same frame of reference as discussed above, finished molded articles are moved from station I to stations IV-II, in that order for forming multilayered molded articles, for example, preforms, via an overmolded liner. For illustration purposes, movable mold half and platen 14d is discussed as moving through each of stations I-IV.

[0055] Accordingly, finished molded articles, such as preforms, are molded on the mold cores of set 34d of movable half 14d and first moved to station IV whereat they are preliminarily cooled while a new set of molded articles, for example, preforms, are molded on movable mold half and platen 14a. Upon a completed rotation, while finished molded articles are being held via vacuum 65 on set of cores 34a on movable mold half and platen 14a at station IV, movable mold half and platen 14d is preferably moved to station III where set of ejector pistons 38d, part of a system actuated via hydraulic services S, and article removal device 67 are used to remove the finished molded articles 39, such as preforms, from the mold cores of set of mold cores 34a.

[0056] Mold half and platen 14d is rotated to station III and finished molded articles 39, such as preforms, from set of mold cores 34a on movable mold half and platen 14a are removed via device 67. At station II, liners 66 are loaded onto set of mold cores 34d of movable mold half and platen 14d for overmolding to form a multi-layer molded article, such as a multilayered preform, at station I. At the same time, movable mold half and platen 14c is moved into alignment with stationary mold half and platen 16, turret block 12 is moved longi-

tudinally toward stationary mold half and platen 16, and a molding operation is preferably performed wherein an outer layer is overmolded over insert liners 66 to form another set of multi-layered articles, such as preforms. Finally, movable mold half and platen 14d with liners 66 on set of mold cores 34d is rotated for engagement with mold half and platen 16 and set of mold cavities 36.

[0057] With regard to the embodiments shown in FIGS. 11, 11A and 12, substantially the same mode of operation as discussed above is performed for system 110 and blocks 112a and 112b, including, for example, rotation, operations performance, and sequence. However, blocks 112a and 112b with mold halves 114a-114d are moved into position with mold half and platen 116 in the vertical direction on tie bars 144a-144d and the operations are performed at an elevated level. In these embodiments, significant floor space reduction is attained, as the machines, due to the vertical arrangements, instead consume above the floor air space, allowing for the use of more machines in less floor space. Other variations in operation are obvious from the description set forth above.

[0058] If, in any of the operations discussed above, a molded article formed from more than one material is desired, the plurality of injection units 18a and 18b may be used along with the two material hot runner system 52, as discussed above, for molding articles formed from more than one material.

[0059] Any combination of the post-molding and premolding operations can be performed at the plurality of stations I-IV, wherein the embodiments given above are by way of example only. While it is shown and preferred that the mold cores be located with the turret block, it may also be possible to switch the positioning of the mold cores and cavities among the turret block and stationary platen if a movable injection unit is used. Resin, therefore, would be supplied to the mold cavities through services S.

[0060] Referring to the embodiment of FIG. 13, at station III is a multicavity blow mold 201 having one blow mold cavity for each preform on the turret face. The multicavity blow mold 201 is mounted on platen 202 which is reciprocated from a blowing position shown in FIG. 13 to an ejection position shown in FIG. 14 by cylinders 203 mounted on platen 202 and whose rods 204 project through the platen and are fixed to turret carriage 205. Thus, when the carriage 205 moves towards and away from stationary platen 16, the multicavity blow mold 201 travels with it in either the blowing or ejection positions.

[0061] In operation, the blow mold can be closed for blowing when the injection mold is closed for injection molding at station I as shown in FIG. 1. Alternatively, the blow mold can be positioned in the closed position as shown in FIG. 13 and the blowing operation performed whenever the turret is not rotating since the multicavity blow mold 201 travels with rotary carriage 205. Then to permit rotation of the turret the blow mold is in the ejection position usually when the injection mold is in the

open position as shown in FIG. 8. Blown articles may be stripped from the cores by the opening action of the blow mold, arrow C in FIG. 14, and ejected from the blow cavities of multicavity blow mold 201 when they split sideways into the open position. This splitting action is well known and is not shown in the drawings. The blow articles 207 then fall, as indicated by arrow D in FIG. 14, onto a conveyor (not shown) under the base of the machine. The compressed air supply for blowing may be provided through the cores via services entering the turret block as previously described.

[0062] FIG. 15 shows an alternative embodiment with blow mold cylinders 203 mounted to a fixed block 206, which is affixed to the machine base. Thus, platen 202 is reciprocated conventionally by the cylinders from fixed block 206 to operate as described above.

[0063] A particular advantage of this embodiment is that the construction materials used for the blowing unit and blow mold can be lower in cost because the clamping of the blow mold is performed independently of the damping of the injection mold. The blow clamp force is typically one third or less (for example 100 tons versus 300 tons) than the injection clamp force. Consequently, the blow molds can be made of much less expensive material, as aluminum, etc., than that which is commonly used, and the blow clamp itself can be less costly.

[0064] An additional advantage is that the platen area available for blow cavities is much larger than previously available. For example, FIG. 16 shows a representative preform mold-core layout using 24 cores 208 in the area X by Y. The blow cavities would have the same pitch as the preforms and consequently this compact 4 by 6 core layout can be used to optimize the available platen area. Other layouts may of course also be used and the 24 cavity layout is shown by way of example only, for example, one could readily use a 48 cavity layout. Thus, the present invention provides a very compact and efficient layout suitable for use with a large number of cores, for example, 48 cores, to maximize the utilization of the space available without penalizing cost or cycle time.

[0065] FIGS. 17-19 are side elevational views similar to FIGS. 1-2, with FIG. 17 in the closed position, FIG. 18 in the open position and FIG. 19 showing a simplified, schematic view in the closed position with portions removed for clarity.

[0066] In the embodiment of FIGS. 17-19, turret block 412 of injection molding machine 410 includes injection unit 418, which can be a reciprocating screw or two stage injection (preplasticizing) unit, stationary platen 416, tie bars 444a, b, c, d (only 444a & c shown), clamp units 480a, b, c, d (only 480a & c shown), and clamp stroke cylinder 481. There can be up to four clamp stroke cylinders, but for clarity only one is shown. Clamp base 420 is also shown similar to the other embodiments. Mold cavity 436, shown in FIG. 19 in the mold closed position and in FIG. 18 in the mold open position, the four mold cores 434a, b, c, d (434d not

shown), and movable mold halves 414a, b, c, d are also shown. The operation is similar to that shown in FIGS. 1-2, except that up to four separate clamp or stroke cylinders 481 are used to move turret block 412, and clamping is performed by four clamp units 480a, b, c, d mounted on stationary platen 416. The clamp units engage splines on the ends of the four tie bars 444a, b, c, d. In the mold open position shown in FIG. 18 the tie bars completely disengage from the clamp units as clearly shown.

[0067] FIG. 20 shows an injection molding machine in accordance with a further embodiment and in the mold closed position. FIG. 20 includes turret block 412 and first injection unit 418. The turret block 412 slides on clamp base 420 by means of stroke cylinders 481 mounted on the turret block and attached to stationary platen 416 as shown in FIGS. 17-19. Tie bars 444a, b, c, d (only 444a & c shown) attached to first face 484 of turret block 412 extend from the turret block towards the stationary platen 416. Clamp units 480a, b, c, d (only 480a & c shown) engage the tie bar ends to clamp first mold cavities 436a to mold core set 434a as in FIG. 19.

[0068] FIG. 20 also shows cylinder rods 482a, b, c, d (only 482a & c shown) attached to second face 486 of turret block 412 extending from the turret block away from stationary platen 416 and passing through bearings in mounting platen 488 terminating at pistons 490a, b, c, d (only 490a & c shown) inside cylinders 492a, b, c, d (only 490a & c shown) mounted to the back face of mounting platen 488. Mounting platen 488 is free to slide on clamp or machine base 420. A second injection unit 494 mounted via frame 496 to the back face of mounting platen 488, connects via a hole in the mounting platen (not shown) to second mold cavities 436b attached to mounting platen 488. Therefore, in the closed position at station III the third core set 434c is clamped via cylinders 492a, b, c, d to second mold cavity 436b to form a second shot injection cavity while a first shot injection cavity is formed at station I.

[0069] FIG. 21 shows the machine of FIG. 20 in the open position with turret block 412 rotated 90° clockwise from the position shown in FIG. 20. The clamp units have released tie bars 444a, b, c, d (only 444a & c shown) and stroke cylinders 481 have moved turret block 412 away from the stationary platen 416. Simultaneously, or a short time later or before, cylinders 492a, b, c, d (only 492a & c shown) unclamp the second shot mold set at station III and extend to open second mold cavities 436b. In this mold open position, turret 412 is free to rotate, clockwise in this embodiment, one position to align second core set 434b with first mold cavities 436a and also to align fourth core set 434d with second mold cavities 434b, as shown in FIG. 21. Stroke cylinders 481 and cylinders 492a, b, c, d can be activated simultaneously if desired to close both molding stations at stations I and III and to permit injection of resin from injection units 418 and 494 simultaneously or slightly phased part.

[0070] Intermediate stations II and IV can be used for other functions, as for temperature conditioning, insert loading and/or ejection of the finished parts.

[0071] The clamping of the molds at the two stations I and III differs in clamping force. The units for clamping at station I generate higher forces and are mounted on a fixed platen rigidly mounted to the machine base. In comparison, clamping at station III is done at a comparatively lower force level in a less rigid structure since all components being clamped can slide on the machine base. In cases where a comparatively thin layer of a multilayered article is to be molded, injection and holding of the resin is performed at station I where higher clamp forces and a rigid structure for good alignment is available. Comparatively thick layers of a multilayered article, where less clamp force and rigidity are required, can be molded at station III.

[0072] FIG. 22 is a chart that summarizes some of the operations that typically can be performed at various mold stations I, II, III and IV. The first example shows the molding of a two layered article having a relatively thin first shot inner layer formed from resin "A" and a relatively thick second shot outer layer formed from resin "B". Referring to FIGS. 20-21, in the mold closed position resin "A" is injected from unit 418 to form a first shot layer on the mold cores. The molds at stations I and III are opened and turret 412 rotated one station, in this case 90° in the counterclockwise direction. The thus freshly molded first shot moldings can be temperature conditioned at station II as shown for example in FIG. 9. After a second set of first shot moldings have been molded at station I the molds are opened and turret 412 rotated one more station, another 90°. The first set of first shot moldings are now aligned with the second shot cavities at station III. The molds are closed and injection from both units 418 and 494 simultaneously, or slightly phased apart, produce a finished article at station III as shown in the first example in FIG. 22 and a fresh set of first shot moldings at station I. Second shot injection unit 494 injects second resin "B" to overmold the first shot parts in second mold cavity 436b, thus forming a two layered article having a comparatively thin inner layer molded from resin "A" and a comparatively thick outer layer molded from resin "B". The molds open once again, turret 412 again rotates one station, another 90°, and the finished parts can be ejected at station IV underneath turret 412, possibly into a downstream handling system. The molds open once again and the cycle is repeated.

[0073] The second example in FIG. 22 shows an additional possible molding sequence. In this case, a two layered article is to be molded having a comparatively thick inner layer from resin "A" and a comparatively thin outer layer from resin "B". In this sequence, turret 412 rotates in a clockwise direction and the first shot is performed at station III because only a relatively low clamp force is required. When the turret is rotated from station III to station I the first shot parts from station

III are temperature conditioned at station II, and on further rotation to station I the second shot resin is injected over the first shot resin at station I where high clamp force is required to form a relatively thin outer layer as shown in FIG. 22. Ejection takes place at station IV.

[0074] Thus, by employing the appropriate molds at stations I and III and by rotating the turret in either clockwise or counterclockwise directions, various molding sequences can be used to form a variety of multilayered articles using overmolding. This procedure and apparatus is not limited to two separate and/or different materials. A third injection unit and low clamping mold set can readily be installed at station II, for example, to allow articles to be molded from up to three different resins.

[0075] Alternatively, the second injection unit and mounting platen and second shot cavity can all be mounted at station II as shown in the embodiment of FIG. 23. As shown in FIG. 23, station II includes mounting platen 488' which is moved towards and away from turret block 412 by cylinders 492a', b', c', d' (only 492a' and c' shown). Mounting plate 488' carries second shot mold cavities 436b' on one face which faces towards turret block 412 and second injection unit 494' on its opposite face. The entire assembly is mounted on and travels with turret block structure 498 as it slides horizontally on base 420. In operation, the first relatively thin layer is molded at high clamp force at station I. After a first counterclockwise rotation of 90° to the next adjacent station, station II, the first shot moldings from station I are aligned with the second shot mold cavities 436b' at station II. The low force clamp unit at station II doses and the second injection unit 494' feeds the second material to form a relatively thick overmolded second layer. Stations III and IV can be used for subsequent cooling, ejection or other operations during the same cycle of the machine. As before, if the relatively thick layer is desired to be molded first, then this is done at station II and the turret block 412 rotates clockwise to perform the second shot, followed by relatively thin layer overmolding at station I, followed by cooling at station IV and ejection of the finished parts at station III.

[0076] FIG. 24 shows another embodiment wherein an insert is added to the structure of the article. In this embodiment, an insert loading robot 500 is shown schematically at station II, but could also for example be shown at station IV, or for the embodiment of FIG. 23 at stations III or IV. At some point in the cycle the robot loans an insert 502 onto a freshly molded article or onto an empty core. The insert can then be completely or partially enclosed with one or two subsequent molding steps, or can simply be bonded to the outside of the article. Obviously, various thickness layers can be included by the machine or process as described above and a variety of combinations of injections and turret rotational directions can be employed to make a composite article including an inserted piece and injected resin layers.

[0077] FIG. 25 shows a variety of cycles of the machine of FIG. 24. Example 1 shows an article having

a relatively thin inner layer molded from resin "A", an insert added to the outer surface of the inner layer, and a relatively thick outer layer injection molded from resin "B". The cycle starts at station I of FIG. 18 where resin "A" is injected at the high clamp force station. The insert 502 is loaded over the injected resin "A" by robot 500 at station II as shown schematically in FIG. 18, at station III resin "B" is injected over the insert at the low clamp force station, and the finished article is ejected at station IV, the turret rotation being counterclockwise.

[0078] Example 2 shows an article having a relatively thick inner injection molded layer from resin "A", an insert added to the outer surface of the inner layer, and a relatively thin outer injection molded layer from resin "B". The cycle starts at station III where resin "A" is injected at the low clamp force station. At station II, insert 502 is loaded onto resin "A" by robot 500, at station I resin "B" is injected onto the insert at the high clamp force station, and the finished article is ejected at station IV, the rotation being clockwise.

[0079] Example III shows an article having an inner surface formed from an insert, and two outer layers, one partially covering the insert and the other covering both the first shot resin and the insert. The cycle starts at station II where the insert is loaded onto the empty mold core. At station I resin "A" is injected to partially cover the insert, temperature conditioning is done at station IV, at station III resin "B" is injected to cover the insert and the first shot resin "A", and ejection is also done at station III when the "mold open" position is reached and immediately before turret 412 is rotated, clockwise in this application.

[0080] These examples further illustrate the flexibility of the machine and the machine is not intended to be limited to these examples alone. Naturally, many other processing sequences can be performed in which resins can be utilized with or without inserts to form multilayer articles in a convenient and expeditious manner.

[0081] In accordance with the injection molding machines disclosed in detail above, molding cycle time is significantly reduced by comparison to conventional injection molding machines, described above. That is, molded articles may be cooled on the mold cores while other articles are being molded instead of immediately removed after a hold time via ejector. As a result, the mold halves may be separated prior to the completion of cooling since the molded articles, such as preforms, remain on the cores and do not warp or deform since they do not immediately require the integral strength to survive an ejection/stripping action. Accordingly, hold time is substantially eliminated with regard to the molding cycle, reducing the molding cycle by substantially half.

[0082] The primary advantage of this invention is that an energy and space efficient two platen injection molding machine having a reduced cycle time is provided which includes a longitudinally movable and rotatable turret block. Another advantage of this invention is

that a two platen injection molding machine is provided including a longitudinally movable and rotatable turret block, wherein combinations of pre-mold and post mold operations may be efficiently achieved on one machine using different stations of the turret block, thereby reducing cycle time. Still another advantage of this invention is that a two platen injection molding machine is provided having a longitudinally movable and rotatable turret block, wherein operations such as insert loading, injection, label loading, temperature conditioning, and direct unloading of molded articles can be achieved at different angular positions in a continuous and efficient manner using one machine having a plurality of stations, thereby reducing cycle time, floor space consumption, and energy consumption. Yet another advantage of this invention is that an energy, cycle time and space efficient two platen injection molding machine is provided having a rotatable turret block which includes a plurality of movable mold clamps for forming molds for the injection molding of articles. And yet another advantage of this invention is that a two platen injection molding machine is provided using a movable and rotatable turret block which turret block includes a plurality of mold halves movable toward and away from a mating stationary mold half for forming molds for injection molding articles in an energy and cycle time efficient manner. And another advantage of this invention is that a two platen injection molding machine is provided including a rotatable turret having a plurality of mold half sides and a plurality of stations to which the mold half sides are rotated for pre-molding and post molding operations.

Claims

1. Injection mold comprising:

a first mold half (14, 114, 414) aligned with a second mold half (16, 116, 416, said first mold half including one of at least one mold cavity (36, 136, 436) and at least one mold core (34, 134, 434) matable with said second mold half for forming a mold for molding a molded article (39); wherein said first mold half (14, 114, 414) is carried by rotatable turret means (12, 112, 412) of an injection molding machine, said turret means rotatable on a horizontal axis perpendicular to the central axis of said first mold half (14, 114, 414) of an injection molding machine, for rotating said first mold half thereof into alignment with said second mold half (16, 116, 416); and wherein said turret means is operative for clamping said first and second mold halves together and wherein said turret means is adapted for being rotated and moved relative to said second mold half; **characterized in that** said first mold half (14, 114, 414) is mounted on

said rotatable turret means (12, 112, 412) and is rotated relative to said second mold half (16, 116, 416) by said rotatable turret means, with said first mold half being at least one of horizontally and vertically movable toward and away from said second mold half via means for moving (40, 418), wherein said first mold half is stationary and supported by a frame (20).

2. Injection mold according to claim 1, wherein services (S) are provided to said first mold half through said rotatable turret means.

3. Injection mold according to claim 1, including greater than one of said first mold halves.

4. Injection mold according to anyone of the preceding claims 1- 3, wherein said rotatable turret means (12, 112, 412) is mounted between at least two carriers that ride on said frame, and including tie bars (44, 144, 444) engaging said turret means (12, 112, 412), and wherein said rotatable turret means (12, 112, 412) is at least partially guided on said frame, and wherein at least one of said tie bars and said carriers are connected with said means for moving (40, 481).

5. Injection mold according to anyone of the preceding claims 1- 4, further including rollers (22) engageable with hardened ways (24) on which said rotatable turret means (12, 112, 412) is longitudinally movable toward and away from said second mold half (16, 116, 416).

6. Injection mold according to anyone of the preceding claims 1- 5, wherein said rotatable turret means (12, 112, 412) is rotatable through arcuate sectors (I, II, III, IV), preferably each spanning an angle of substantially 90°, for moving each of said first mold halves to at least one work station positioned at the beginning of at least one of said arcuate sectors.

7. Injection mold according to anyone of the preceding claims 1 to 6, wherein each of said first mold halves (14, 114, 414) include said at least one mold core (34, 134, 434) for insertion in at least one mold cavity (36, 136, 436) of said second mold half (16, 116, 416).

8. Injection mold according to anyone of the preceding claims 1 to 7, comprising:

a turret block rotatable on the horizontal axis, said turret block including a plurality of faces for accommodating said plurality of said first mold halves (14, 114, 414); said turret block for clamping being longitudinally movable towards and away from said sec-

ond mold half;
means for guiding said tie bars (44, 144, 414)
extending into said turret block.

9. Injection mold according to anyone of the preceding 5
claims 1 to 8, further including at least one means
for performing at least one operation in addition to
said molding.
10. Injection mold according to claim 9, wherein said at 10
least one means for performing comprises:

means (38) for ejecting molded articles from
said mold cores included in each of said first
mold halves (14, 114, 414), said means for 15
ejecting preferably comprise hydraulically actu-
ated ejector pistons (38), and/or
means for temperature conditioning (54) said
molded articles after said molded articles are
formed, said means for temperature condition- 20
ing positioned adjacent at least one of said first
mold halves, and/or
means (67) for removing said molded articles
from each of said first mold halves while said
molded articles are ejected from said mold 25
cores.
11. Injection mold according to claim 9, wherein said at
least one means for performing comprises a blow
molding station (III) including a blow mold posi- 30
tioned adjacent each of said mold cores (34).
12. Injection mold according to claim 11, wherein said
blow molding station (III) includes a multicavity blow
mold (201) with blow mold cavity for each mold 35
core.
13. Injection mold according to claim 12, wherein the
multicavity blow mold is mounted on a platen (202)
which is reciprocated from a blowing position to an 40
ejection position.
14. Injection mold according to claim 13, including
means for moving (203) said platen (202) with the
movement of said rotatable turret means relative to 45
said second mold half.
15. Injection mold according to claim 1, wherein said
rotatable turret means (412) is rotatable on an axis
for rotating said first mold halves thereof into align- 50
ment with said second mold half (416) at a first
injection station (418), and is rotatable on an axis
for rotating said first mold halves thereof into align-
ment with a further mold half at a second injection
station (494) spaced from said first injection station. 55
16. Injection mold according to claim 15, including first
means (444) for relatively moving said first and sec-

ond mold halves from a mold open to mold closed
position at said first injection station, and second
means (492) for relatively moving said further mold
half and first mold half from a mold open to a mold
closed position at said second injection station.

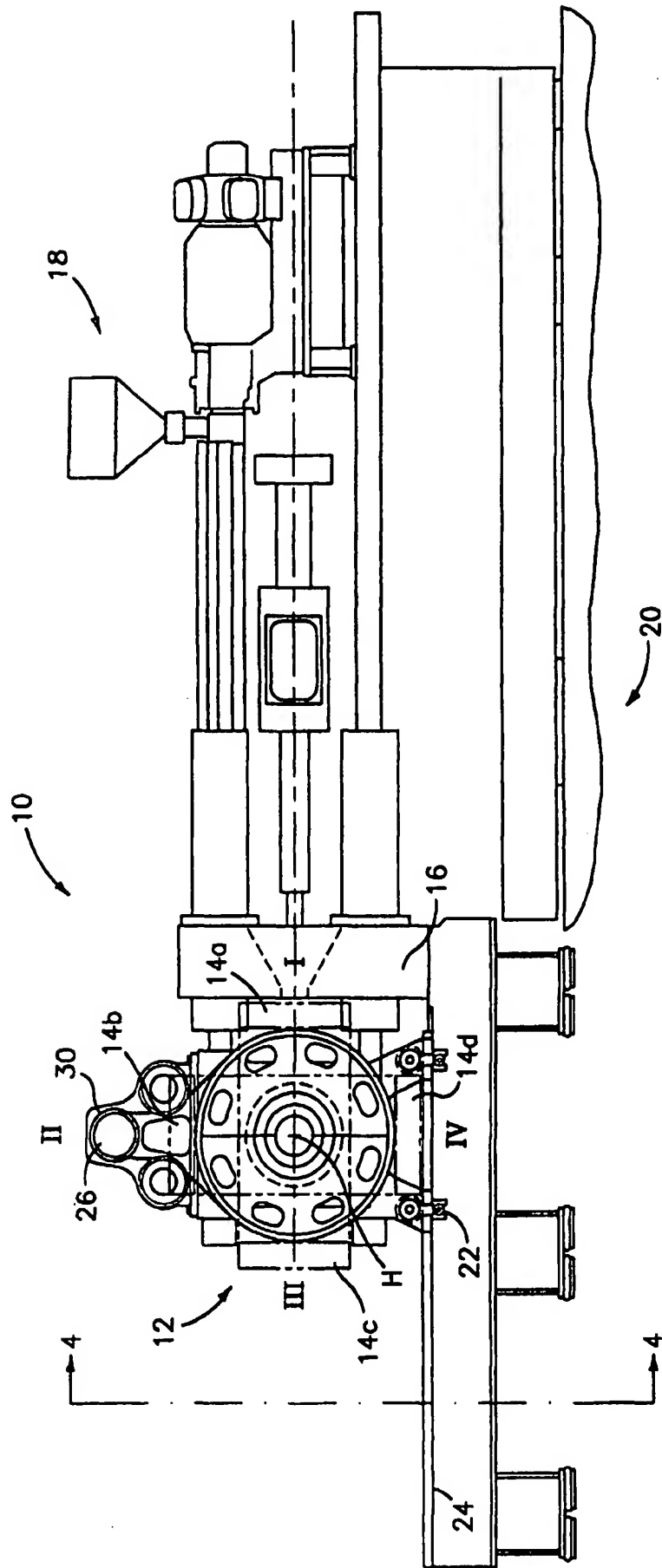


FIG. 1

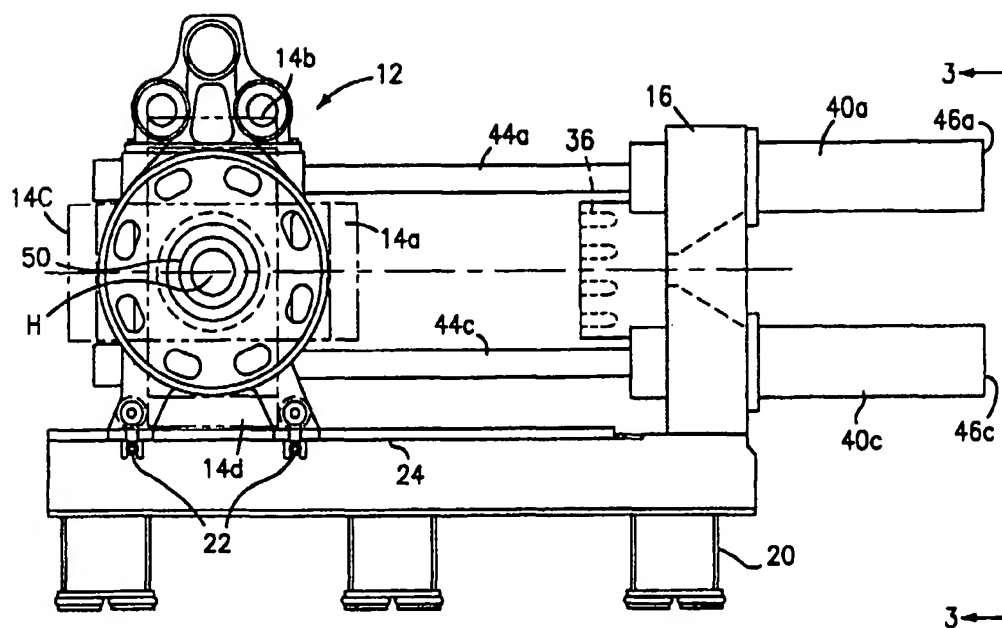


FIG. 2

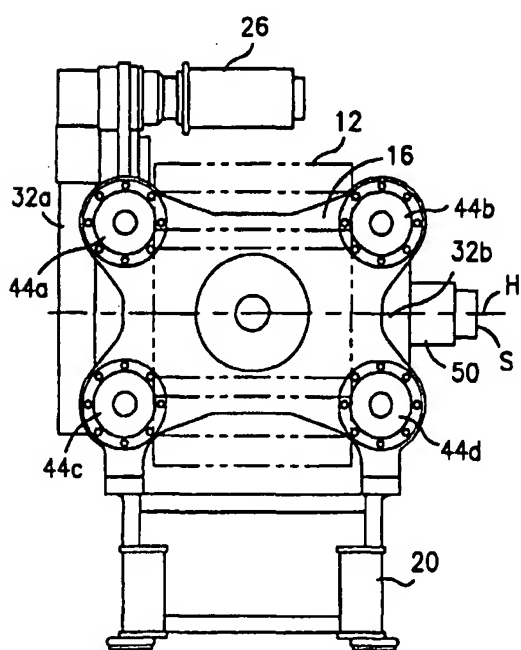


FIG. 3

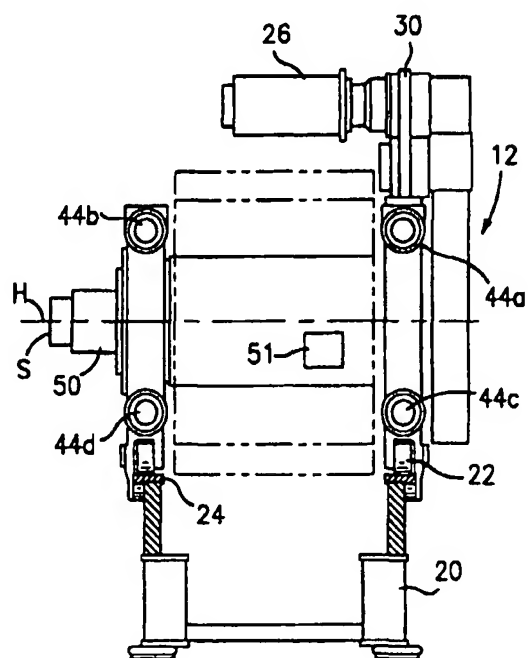


FIG. 4

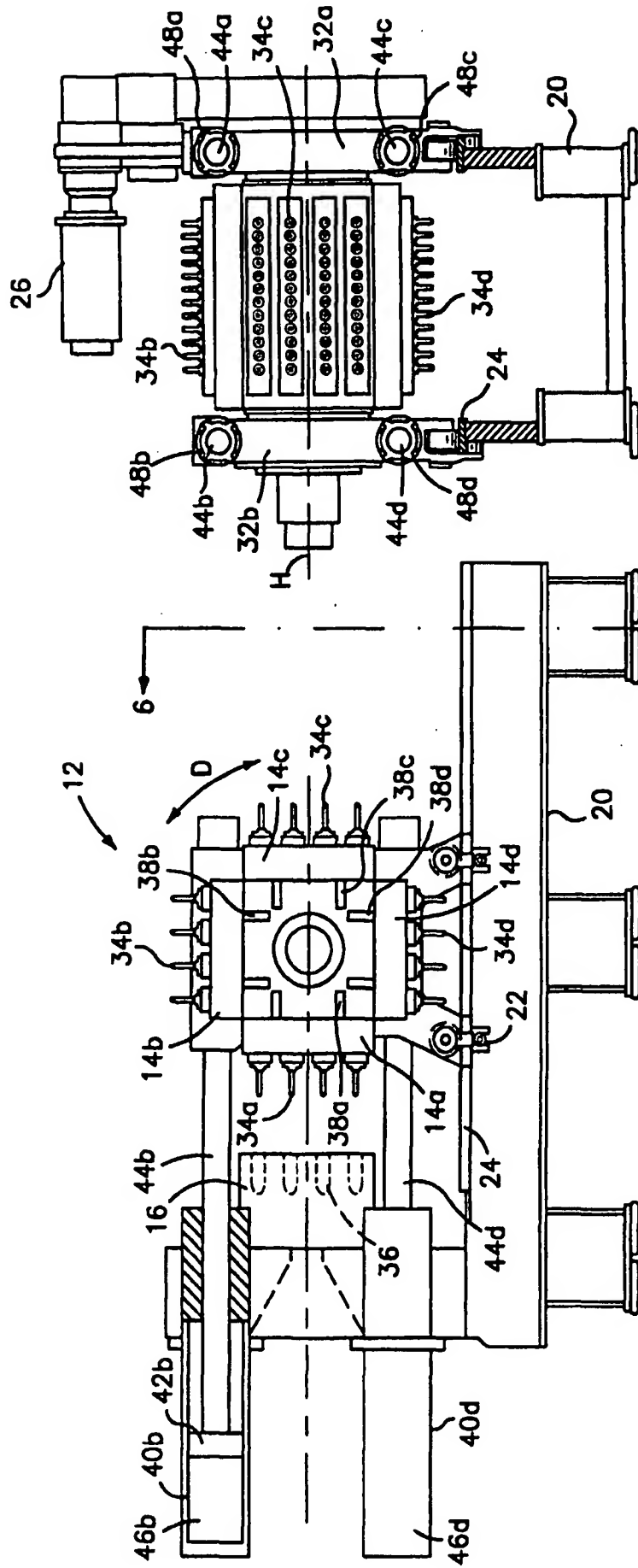
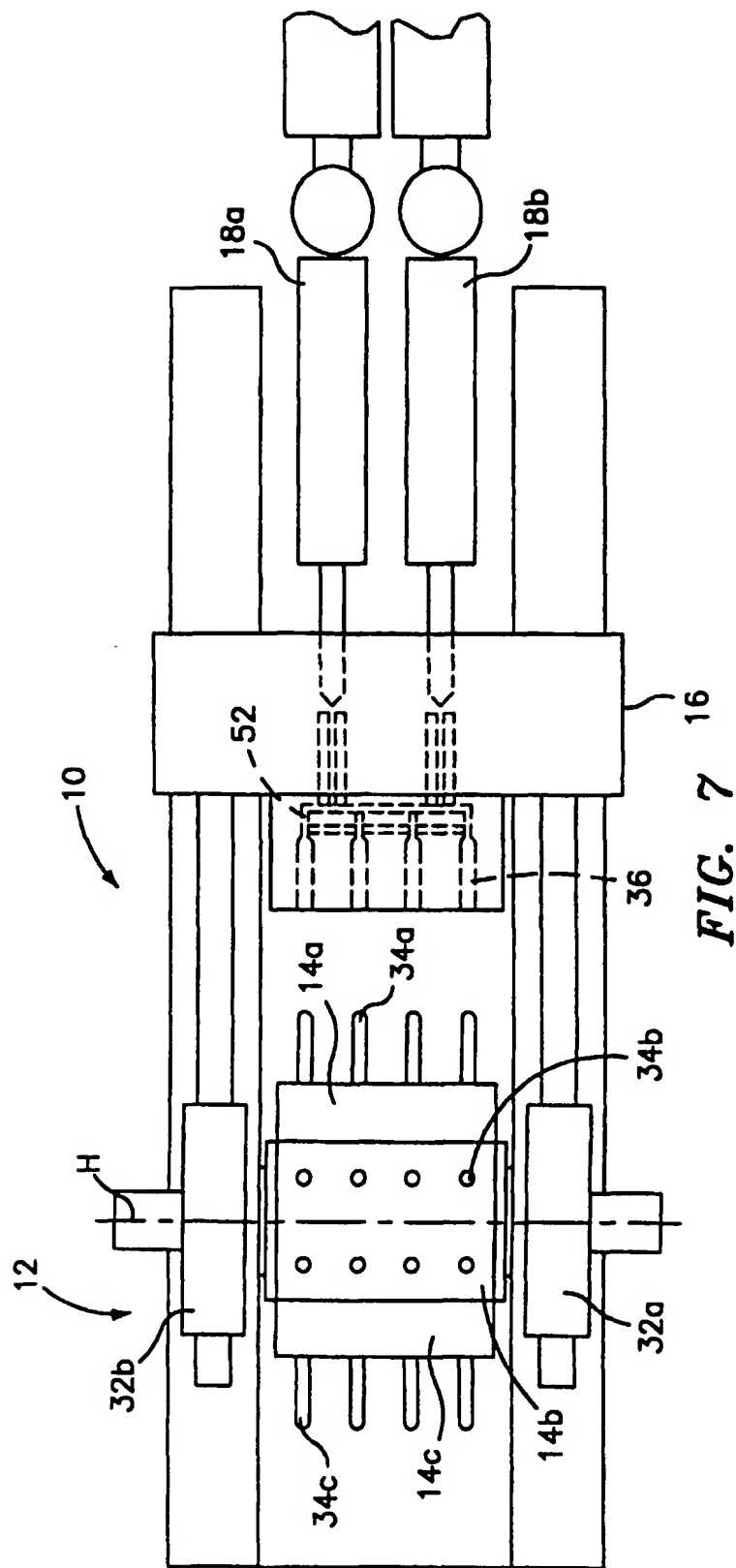
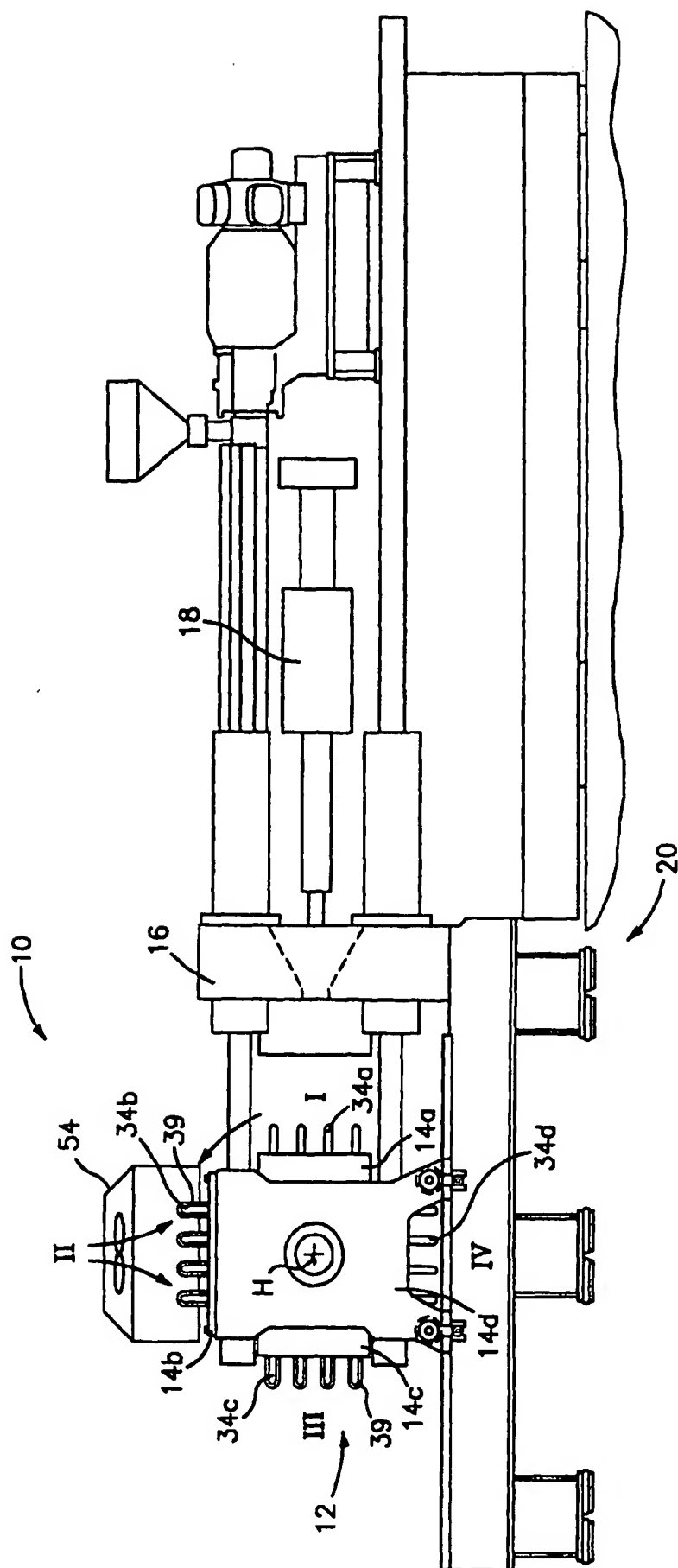


FIG. 6

FIG. 5





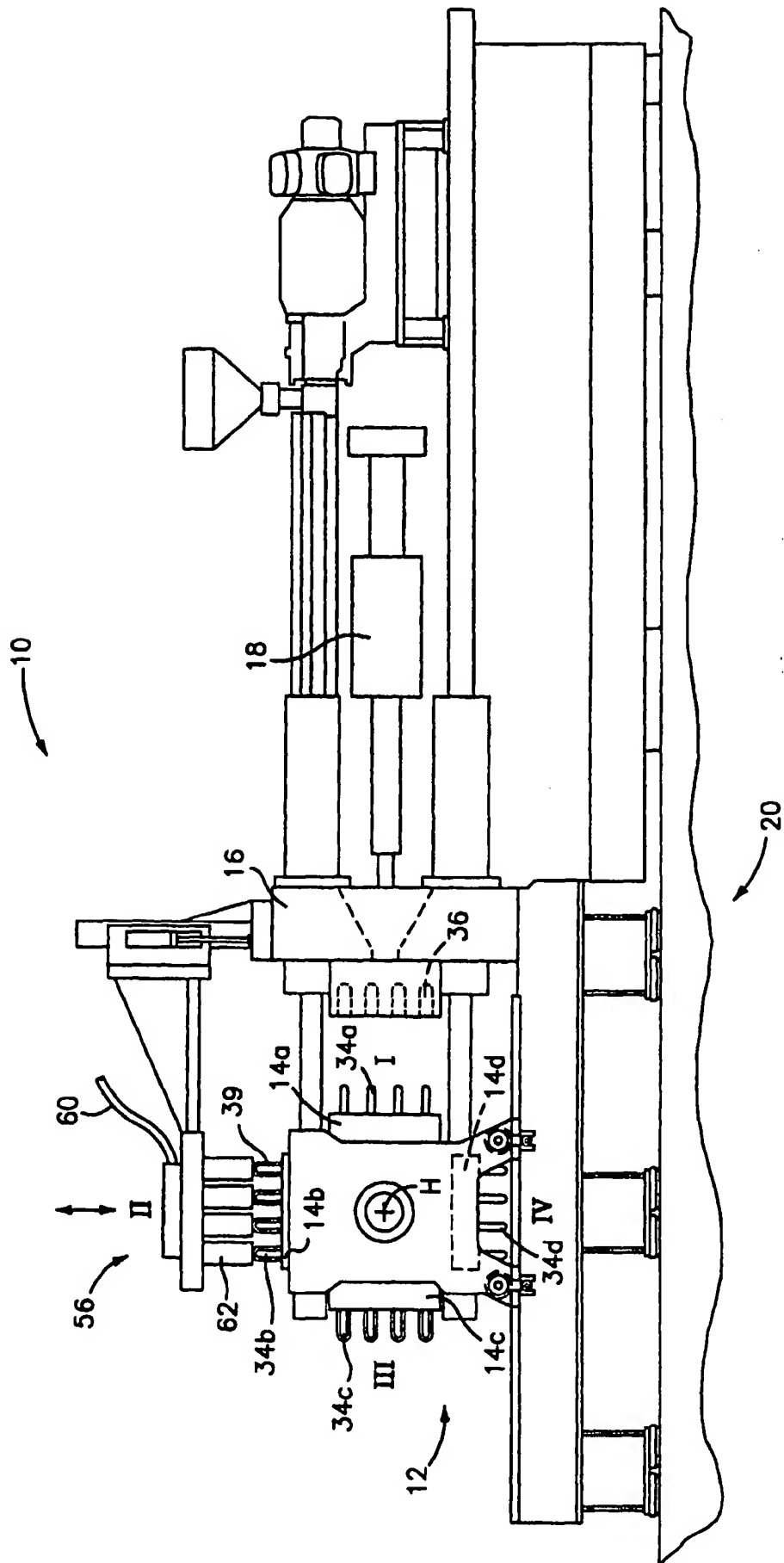


FIG. 9

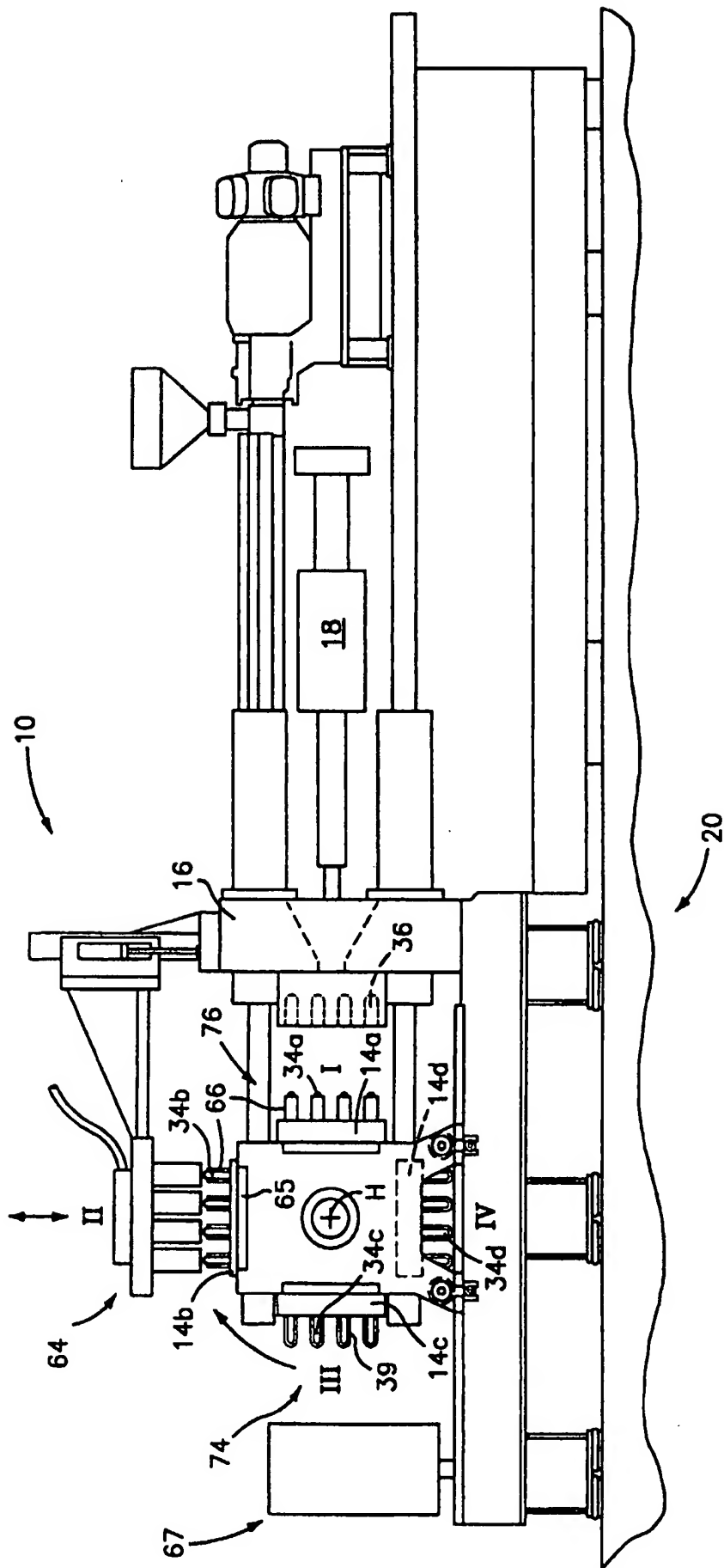


FIG. 10

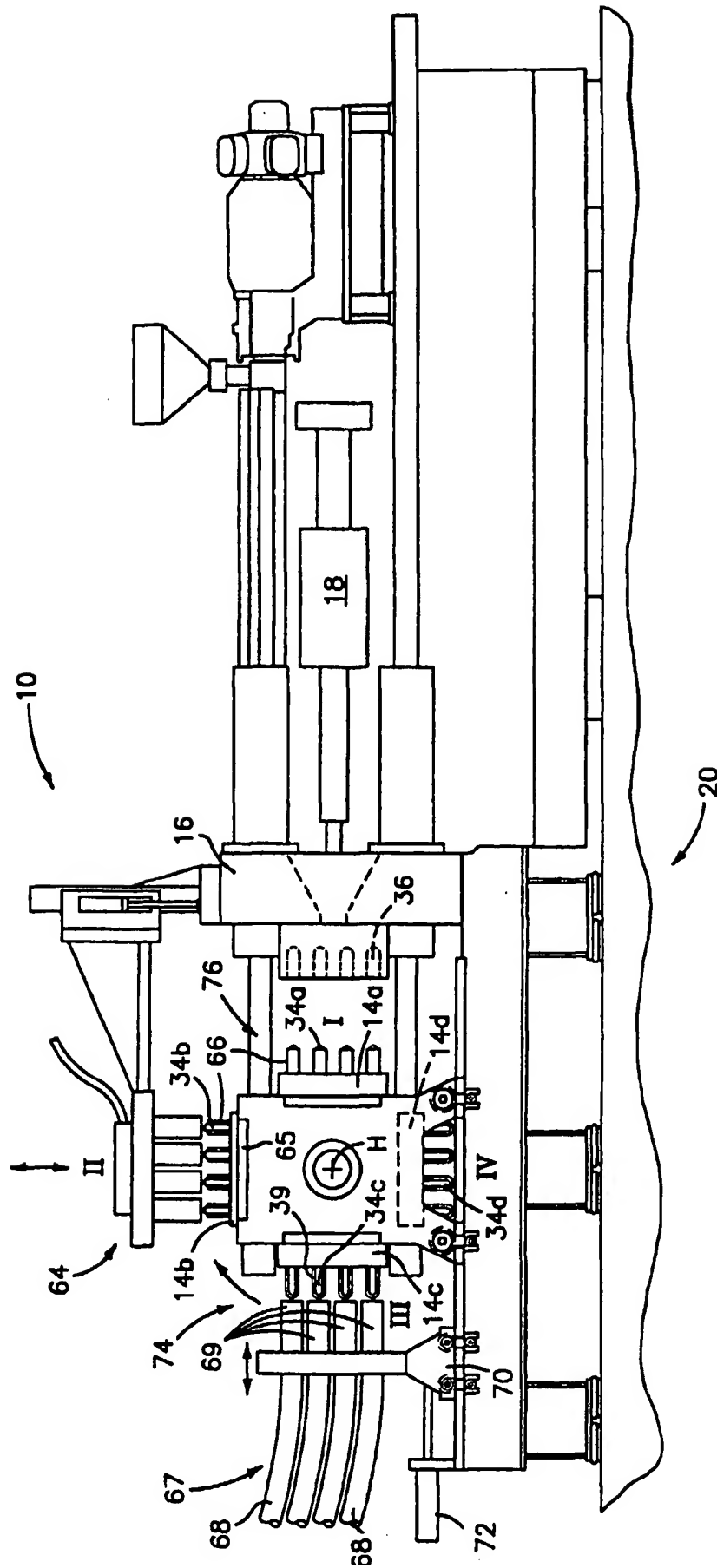


FIG. 10A

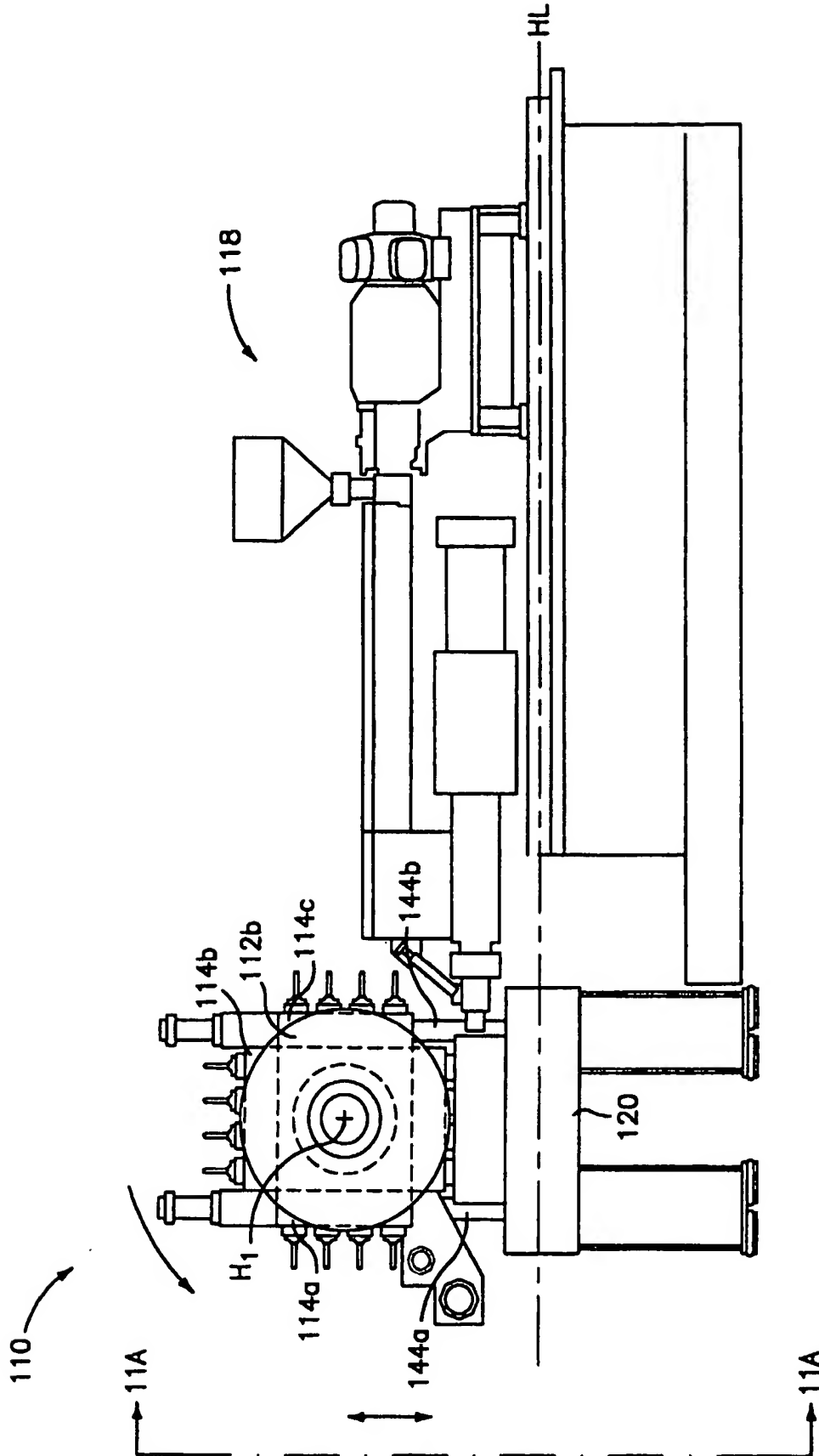


FIG. 11

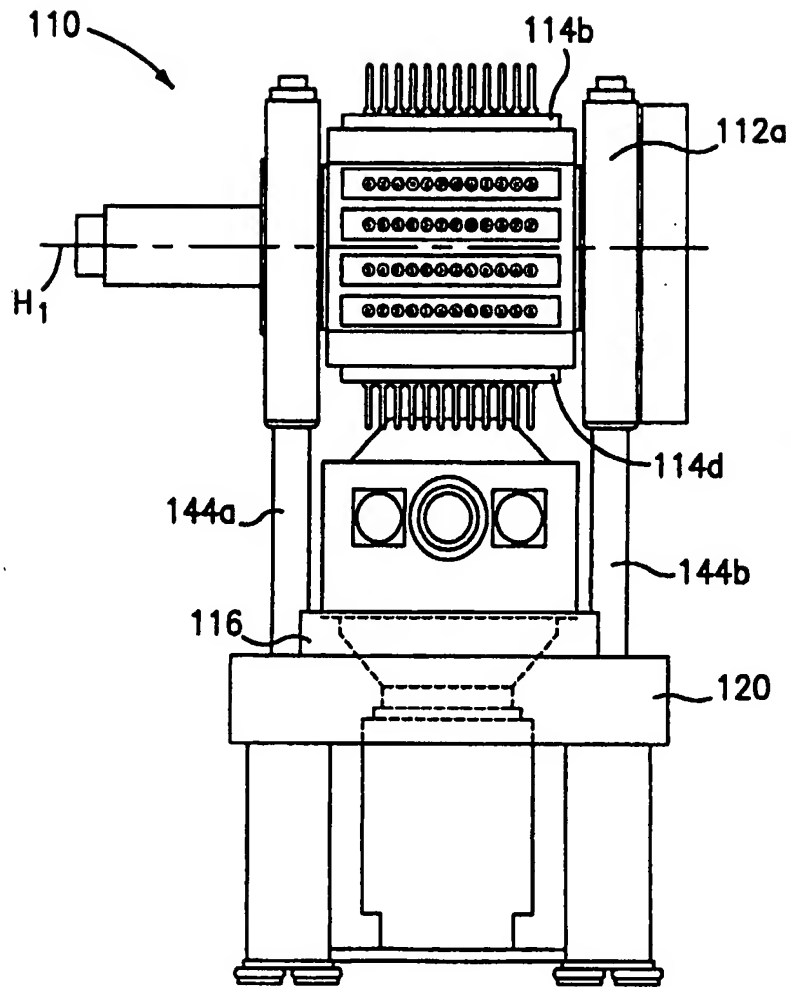


FIG. 11A

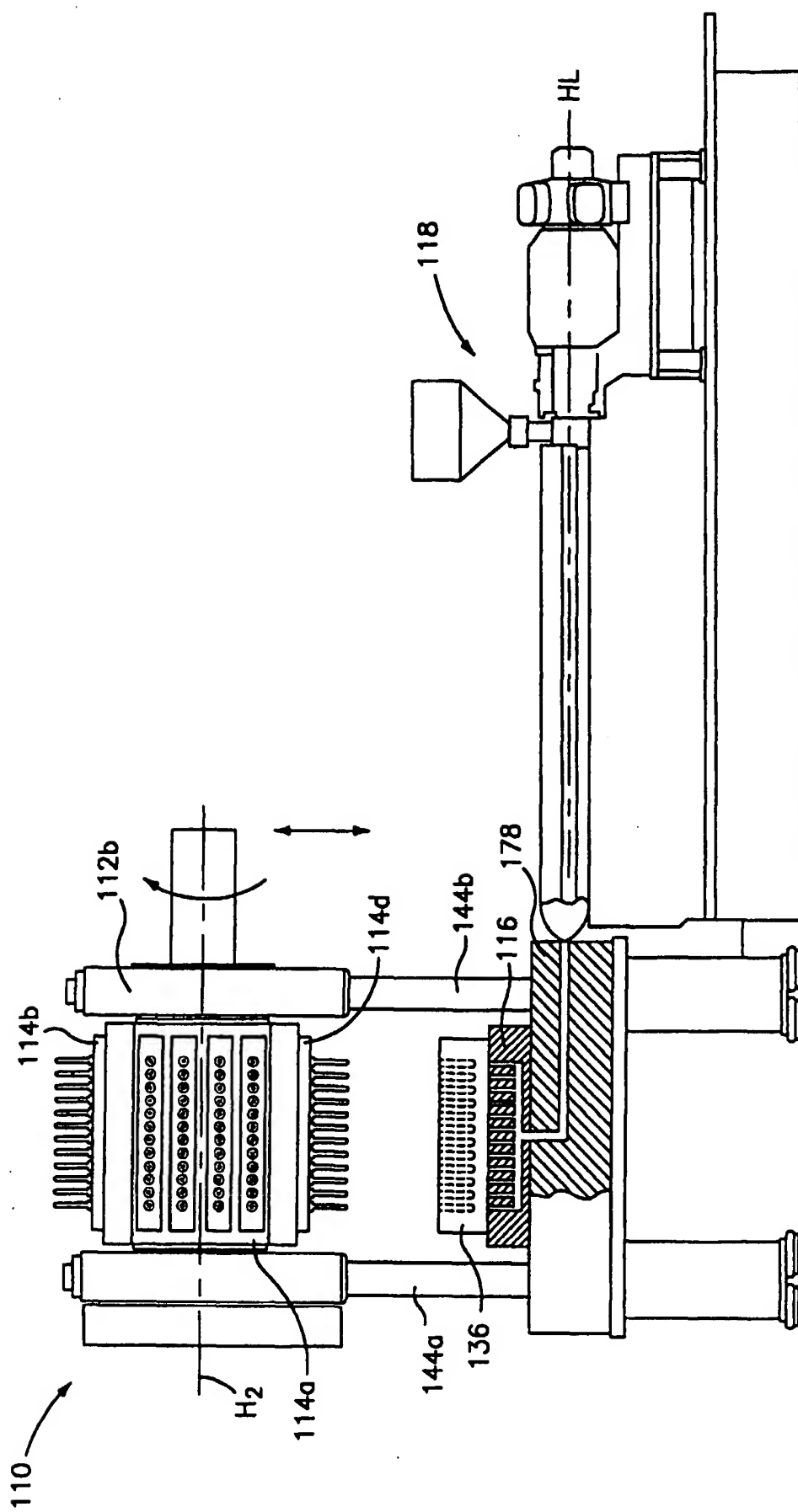
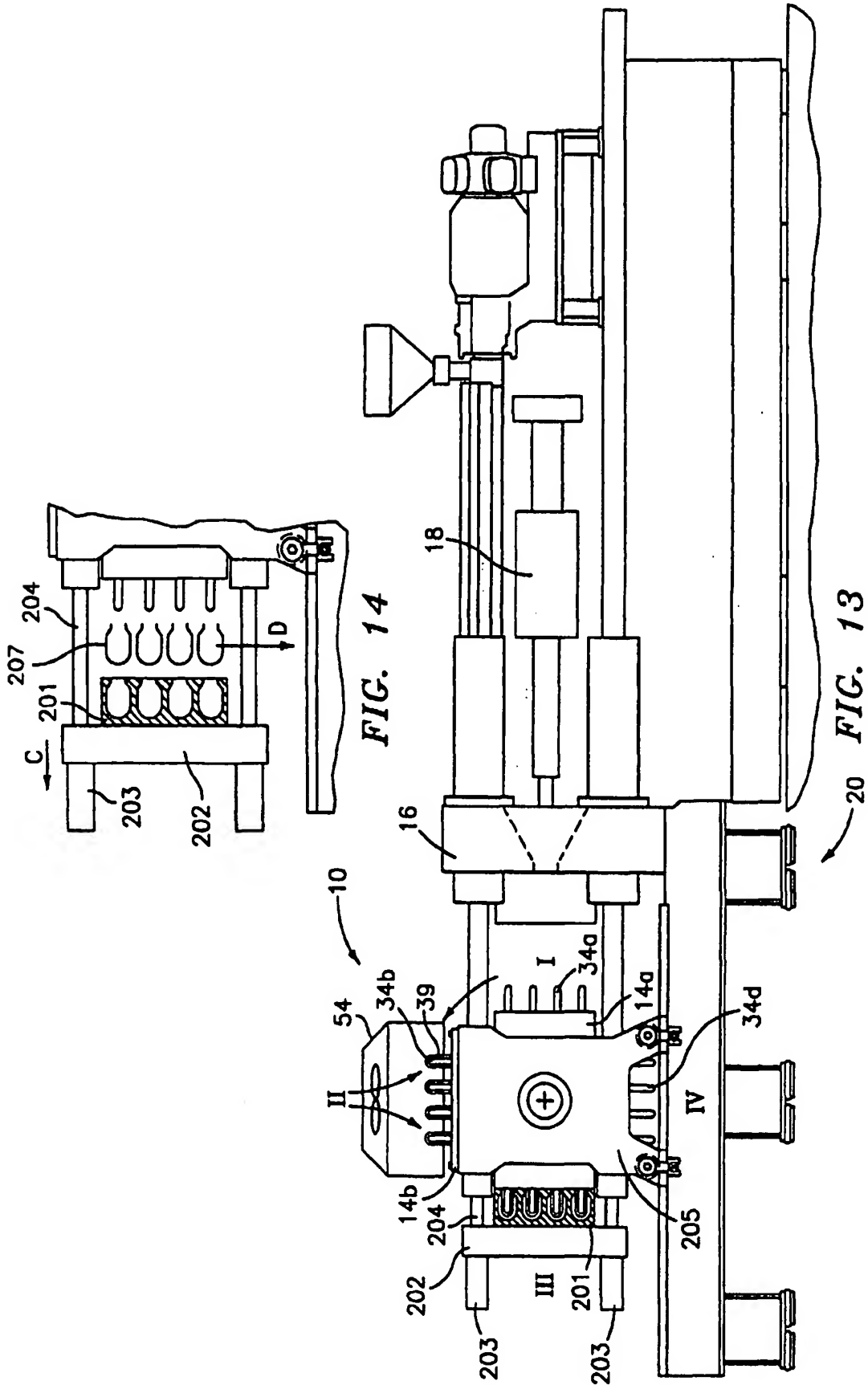


FIG. 12



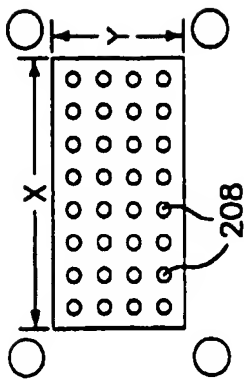


FIG. 16

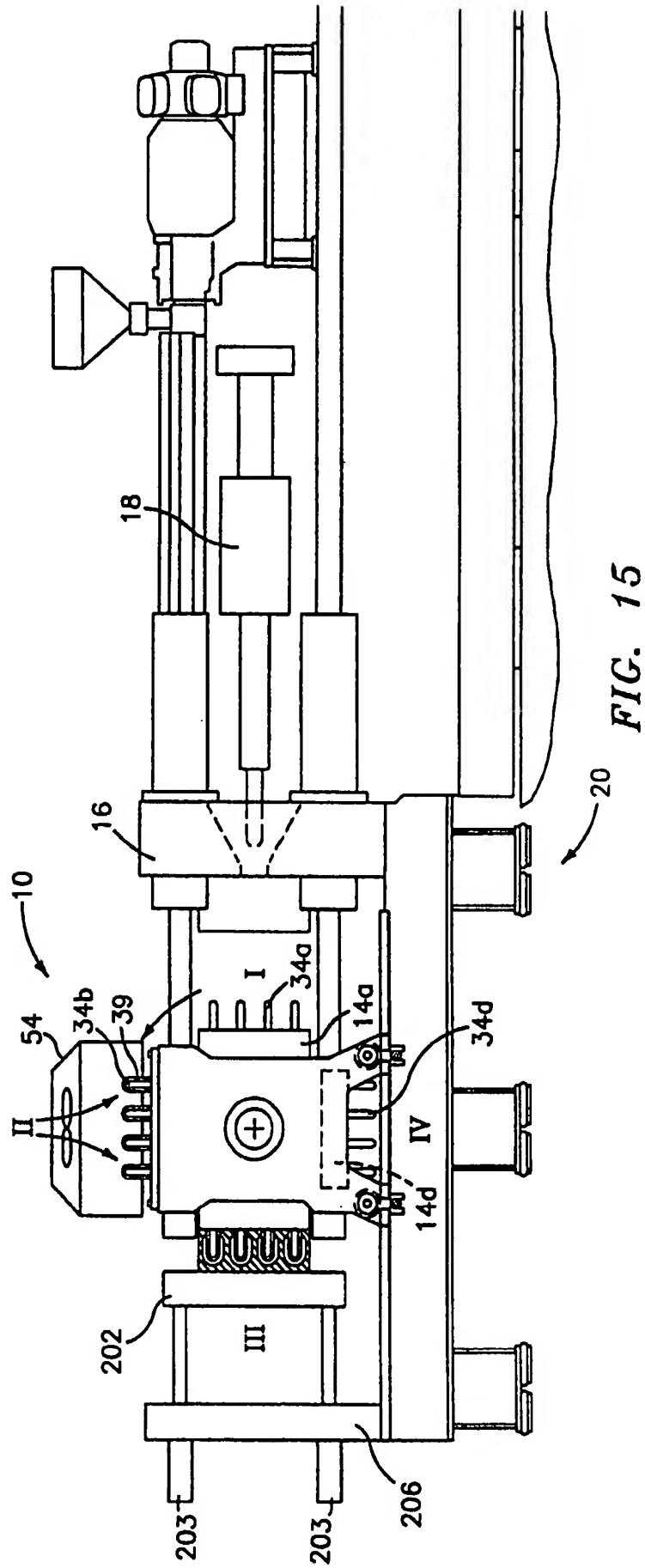


FIG. 15

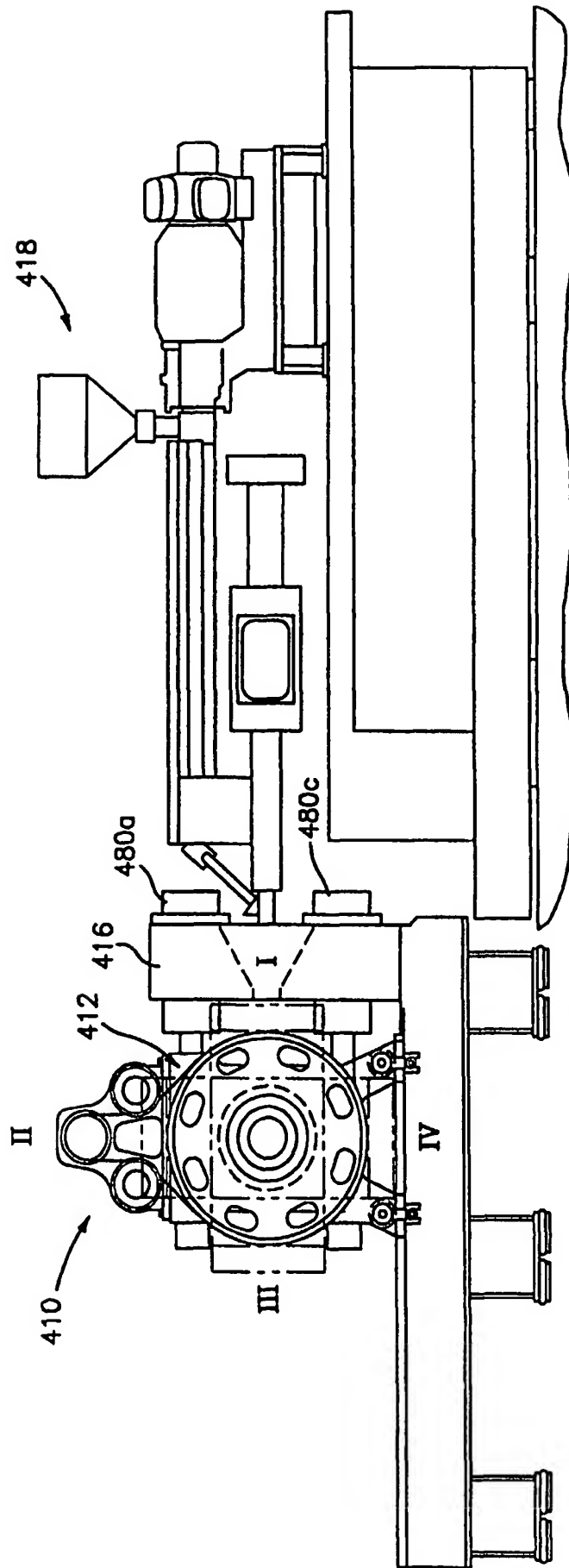


FIG. 17

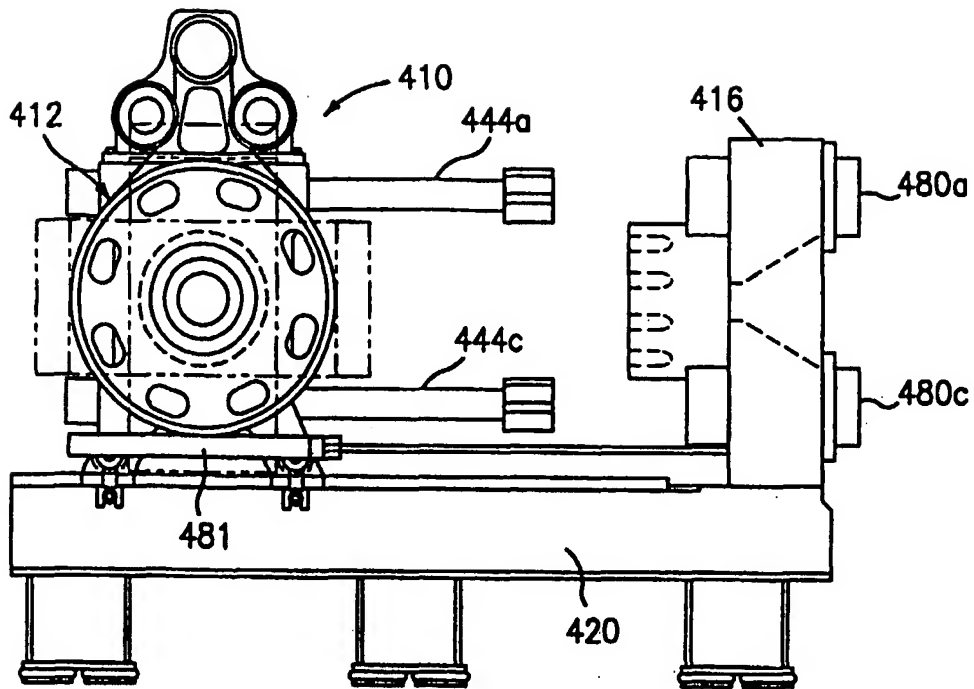


FIG. 18

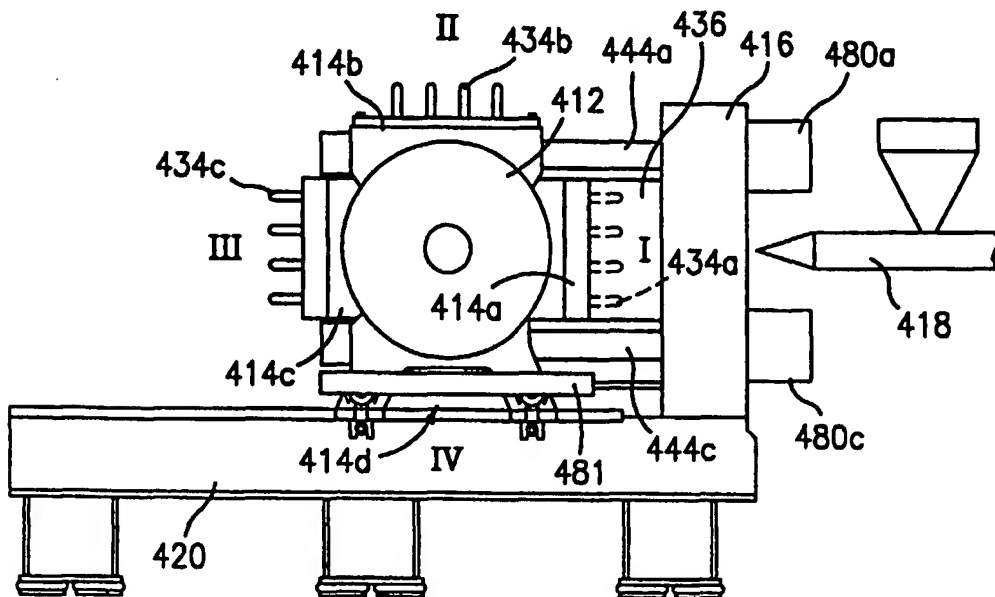


FIG. 19

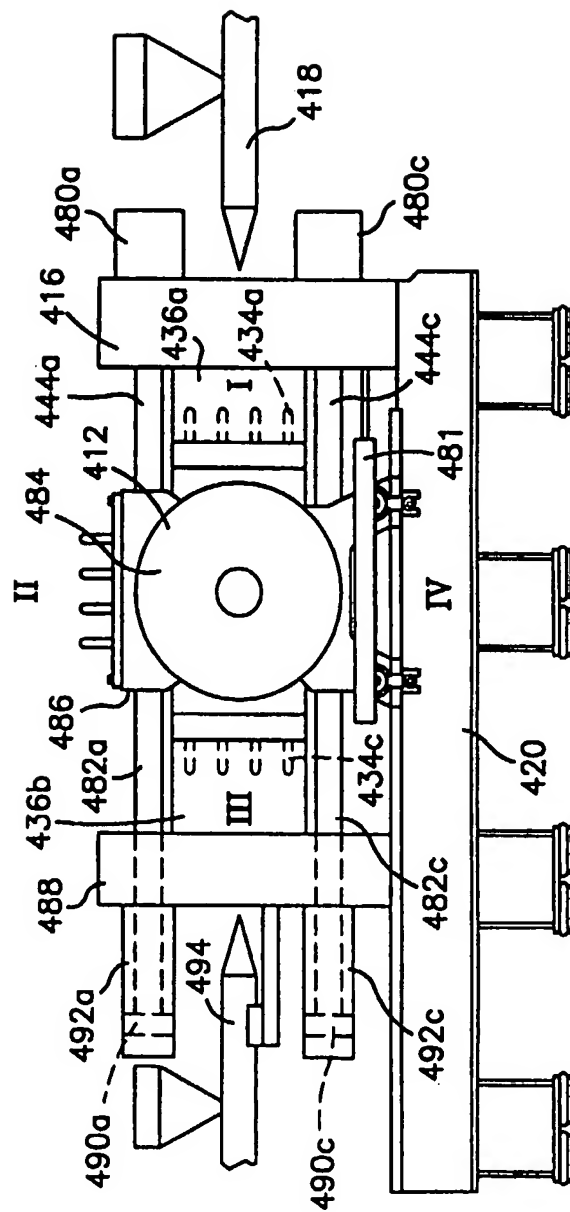


FIG. 20

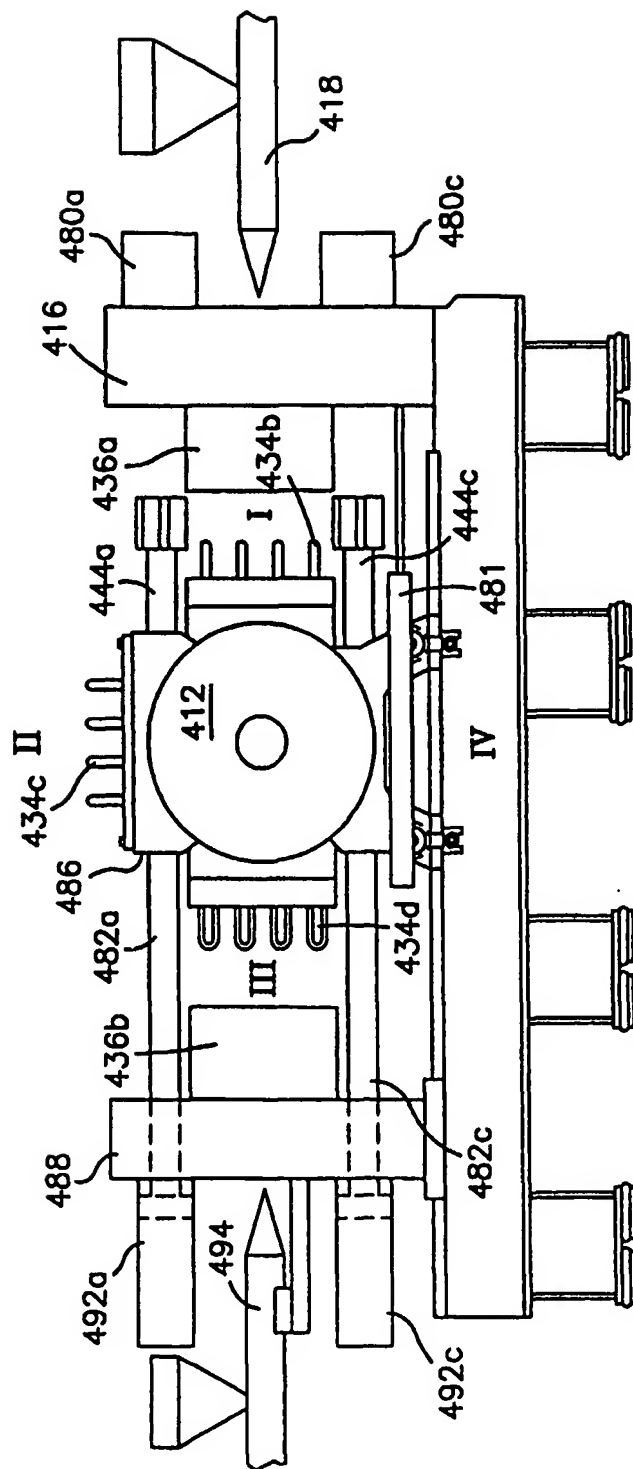


FIG. 21

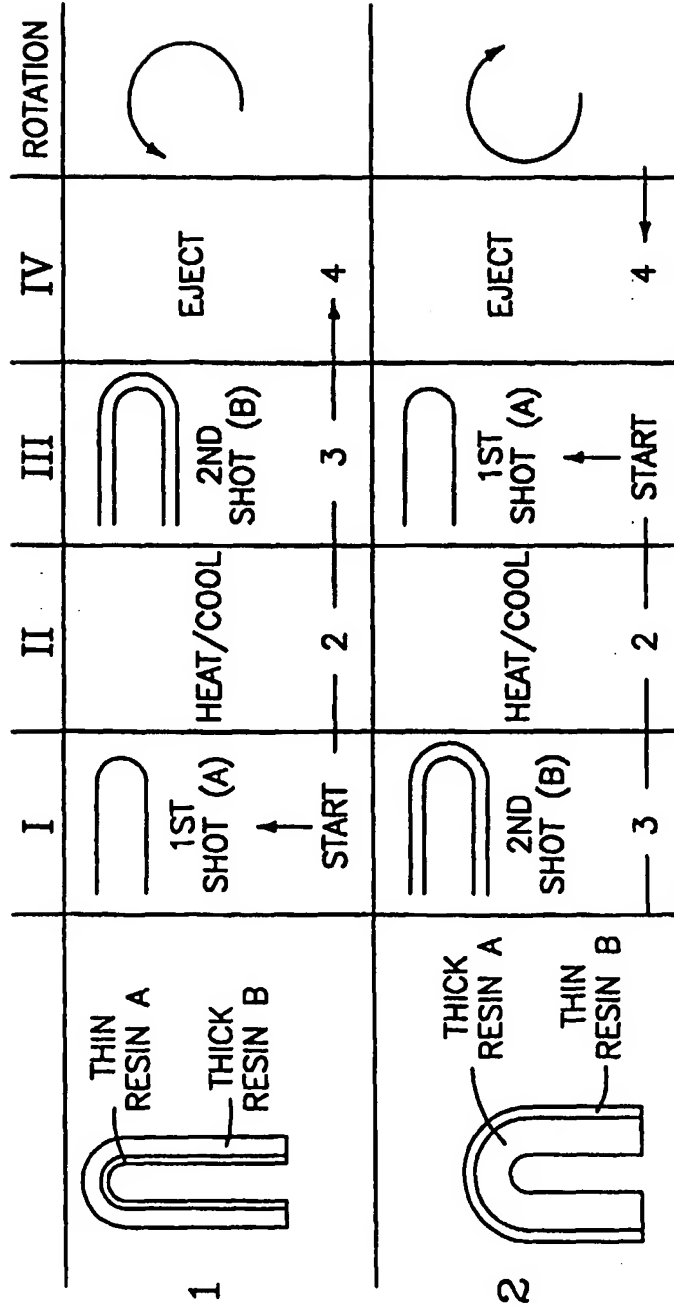


FIG. 22

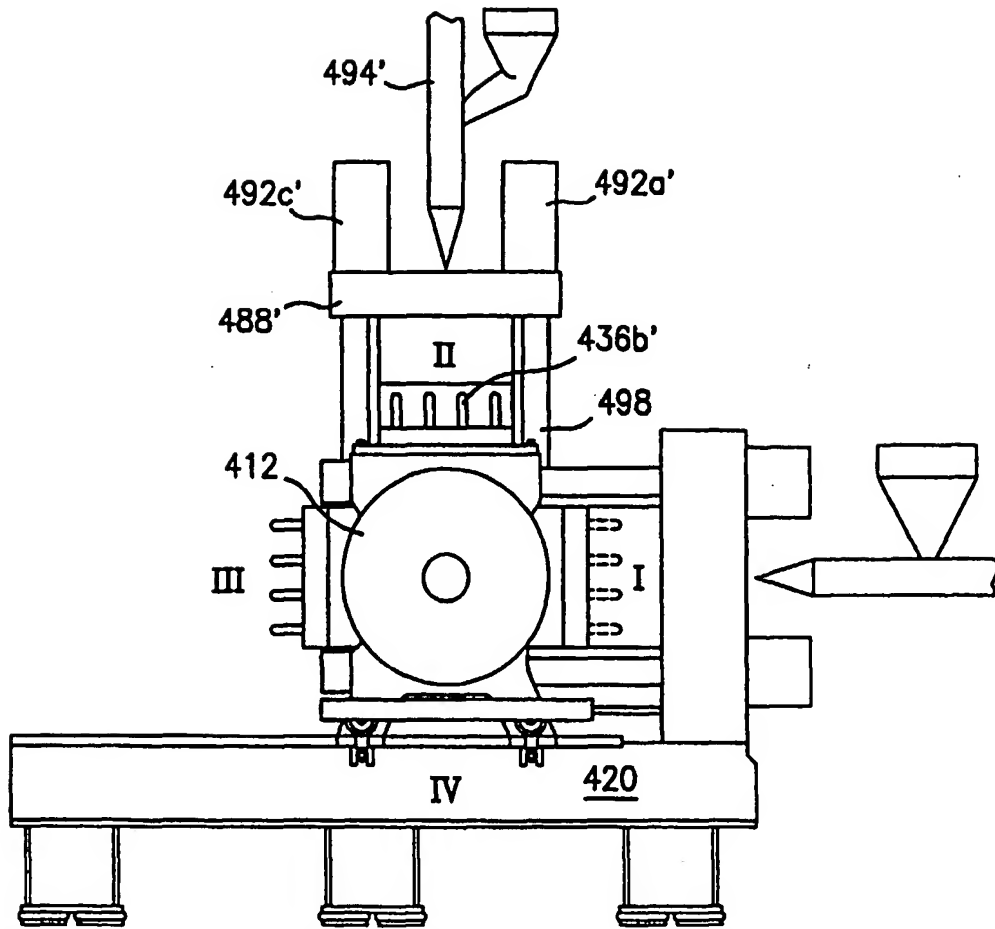


FIG. 23

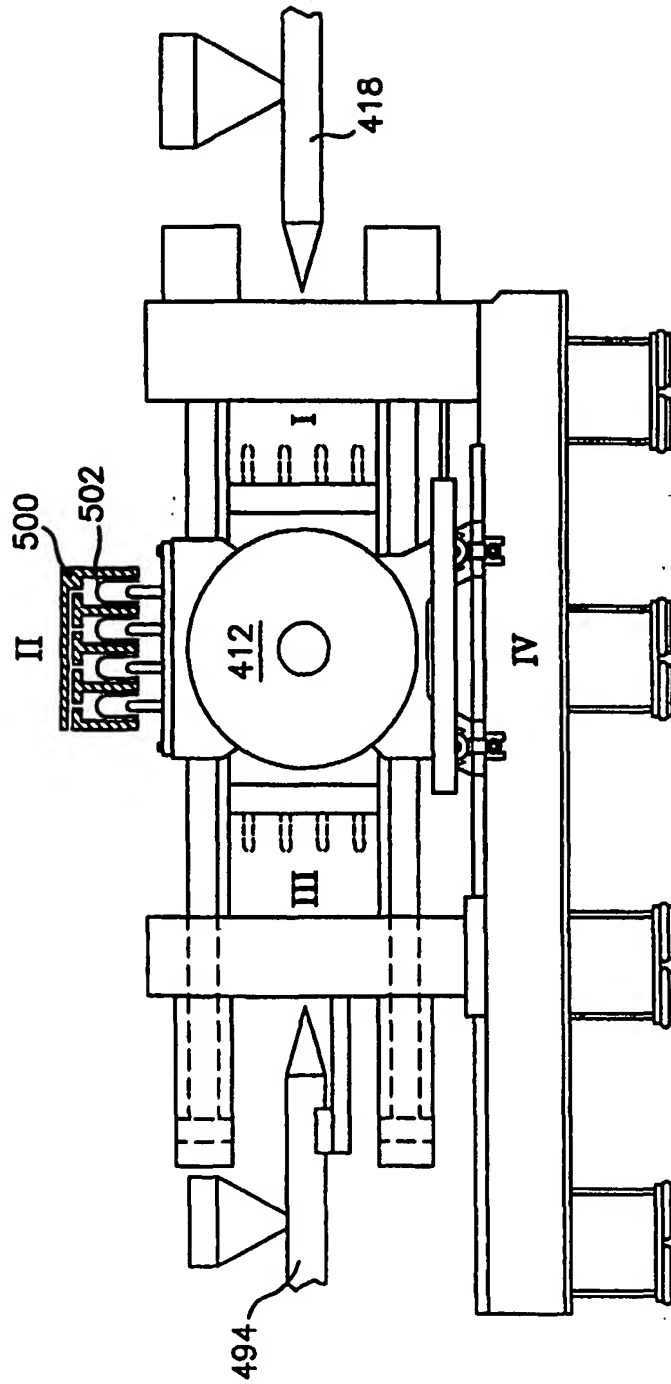


FIG. 24

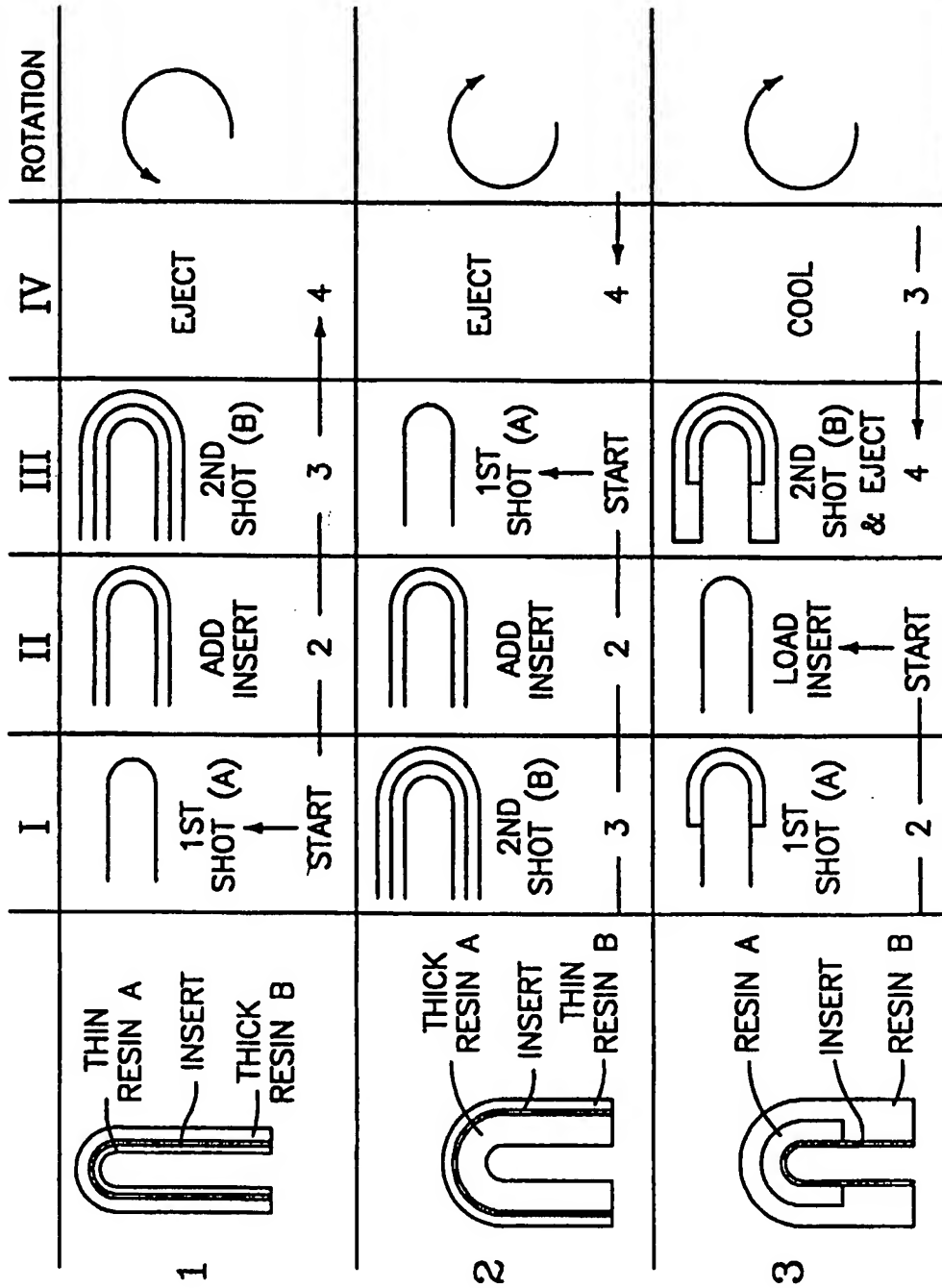


FIG. 25



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Application Number
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